POWER

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The Federal Water-Power Commission

Sec. of War
NEWTON D. BAKER

Sec. of the Interior
JUDGE JOHN BARTON PAYNE

Sec. of Agriculture
EDWIN T. MEREDITH

Newton D. Baker, John Barton Payne and Edwin T. Meredith, respectively Secretaries of War, Interior and Agriculture, make up the Federal Water-Power Commission as provided in the recently enacted Water Power Bill. The Commission will issue fifty-year licenses for power projects and transmission lines and will pass upon the scheme of development of power sites, plans and specifications of the works, upon certain features of maintenance and operation and will have jurisdiction over the regulation of rates and service whenever the state has no agency to look after such regulation.

The work will include thorough investigation and collection of data pertaining to the utilization of the water resources of any region where plans for development are contemplated. The Commission will also investigate and compile a report on the water-power industry as a whole and its relation to other industries and to interstate and foreign commerce.

The bill provides for an investigation and report on the Great Falls power project on the Potomac above Washington, and reports on all projects on navigable streams in which it appears that construction of suitable structures for unimpeded navigation cannot be undertaken by the applicants for license.

The responsibility for much of the detailed administration of the Water Power Bill will rest with Oscar C. Merrill, formerly chief engineer of the Forest Service, who has been appointed Executive Secretary to the Commission, and the engineering surveys will be placed in the hands of Lieut. Col. William Kelly, who was appointed by President Wilson as engineer officer of the Commission.

It is difficult to estimate the vast benefits of the proper development of our sixty million available horsepower. Only by proper development of these resources can the industrial life of the country reach its maximum. Each year the fuel situation is becoming more acute owing to strikes, transportation difficulties, speculation, etc., but with development of our water-power resources a vast amount of coal will be conserved or rendered available for other work.

The Causes of Trouble in Steam-Turbine Lubrication and the Remedy

By L. E. STROTHMAN
Vice President and General Manager, the Richardson-Phenix Company

Mr. Strothman describes the ordinary circulating system used for the lubrication of a steam turbine. He points out some of the troubles inherent in this simple system and discusses the reasons for these troubles. The various steps in the development of improved systems are traced and their faults and virtues are discussed.

IN THE early days of the steam turbine almost unsurmountable difficulties were experienced with lubrication—largely due to the kind of oil then used, which was not suitable for this severe service. Today the larger sizes of steam turbines are equipped by the manufacturer with an effective circulating oiling system, which can be relied upon to supply an adequate quantity of oil to each bearing.

For the improvement that has been made in lubrication, great credit is due to both the leading manufacturers of steam turbines and the manufacturers of high-grade lubricating oils. The manufacturers of steam-turbine oil have carefully studied the requirements of the service and have consistently followed the subject, through their technical departments, and from data secured in the field on the service obtained from the oil have succeeded in producing the very best oil for the conditions.

Fig. 1 shows graphically the oil-circulating system of a steam turbine. Oil is supplied under pressure to the middle of each bearing, flowing out at the ends and returning by gravity to the oil reservoir *B* in the base of the turbine unit. A rotary pump *A*, driven from the main spindle of the turbine or from an extension of the governor shaft, takes the oil from the reservoir *B* and forces it through oil cooler *C*. A part of the oil is used in the oil-relay system for governing the turbine, and the remainder is reduced in pressure by a reducing valve and is delivered through pipes *D* to the various bearings. A relief valve *L* bypasses any excess oil back into reservoir *B*. The steam-turbine unit, shown, has four main bearings, *E*, *F*, *G* and *H*, and a thrust bearing. The oil, after passing through the bearing, returns by gravity through return pipe *J* and through the screen strainer *K* to the reservoir. The turbine is equipped with an auxiliary oil lamp which is used when starting and stopping the turbine in case of emergency. In pointing out the various causes of trouble in steam-turbine lubrication, it will be taken for granted that a suitable high-grade, pure mineral oil is used. The troubles that would ensue from using a poor grade or an unsuitable oil would be far more serious.

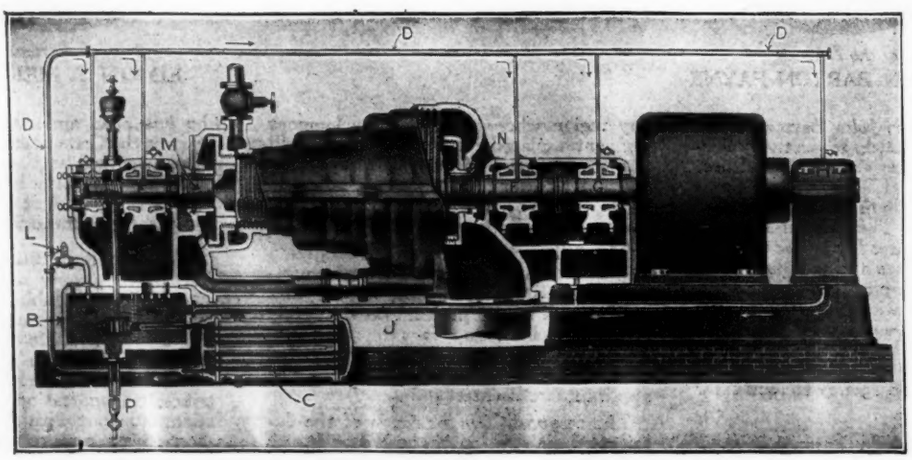


FIG. 1. A TYPICAL SELF-CONTAINED OIL-CIRCULATING SYSTEM ON A STEAM-TURBINE UNIT

In the circulating oiling system of all steam turbines water finds its way into the oil in spite of the precautions taken by manufacturers in the construction of packing glands *M* and *N* (Fig. 1) which are variously fitted with carbon packing rings held against the shaft by springs, labyrinth packing or water seals and water throwers introduced between packing glands *M* and *N* and bearings *E* and *F*. Some water also gets into the oil when the turbine is at rest, owing to condensation of moisture in the air when it comes in contact with the cool metal surfaces of the oiling system. Occasionally, small leaks develop in the oil cooler, permitting water, which is usually supplied under pressure, to get into the oil. As shown in Fig. 1, the bearing shells are sometimes made hollow and cooled by circulating water through them, in which case there is an additional possibility of the bearing shells leaking and allowing water to enter the oiling system.

A drain valve *P* is provided in the bottom of the oil reservoir for drawing off any water in the system, but this drain connection is effective only when the turbine unit has been shut down and sufficient time allowed for the water to separate from the oil and settle to the bottom.

A steam turbine is one of the few power units which is operated continuously, and the oil in the lubricating system, owing to its rapid circulation (from 9 to 40 times per hour, depending upon the size and make of the turbine) and constant contact with hot bearings, air and moisture, receives the most severe service to which lubricating oil is subjected. On account of these severe conditions even the best

turbine oils will, in time, emulsify, oxidize and break down with the formation of sludge and a low degree of acidity, unless means are provided to remove moisture, air, sludge and other foreign matter as soon as they appear, thereby constantly maintaining the oil in its original pure state, which results in its giving good service indefinitely.

Rapid Circulation of Oil

Owing to the limited holding capacity of the turbine oil reservoir and the rapidity with which the oil is circulated, it does not have time to separate from moisture, air or other foreign matter picked up during its circulation, and as the same oil must perform its duty many thousands of times, it is evident that it must receive care in order to prolong its life and enable it to do its work properly. In a closed, continuous, circulating system, it is impossible to know from the outside the condition of the oil and whether water or other impurities are present. Even if samples of oil are taken from the system at frequent intervals and analyzed, the result would show only an approximation of the average condition of all the oil in the system. Any moisture in the oiling system is thoroughly churned up with the oil by the rapid circulation, and an emulsion of water and oil is formed.

Oxidation of the Oil

The oil in circulation always contains more or less air and, furthermore, is exposed to the atmosphere in the bearings. In addition to coming in contact with air the oil at the same time comes in contact with the heated surfaces of the bearings. Bearings become heated from a number of causes, such as the heat generated due to friction, which may become excessive if a heavy oil is used; also the heat transmitted from the steam in the turbine cylinder, etc. This combination of air and heat causes the oil to become oxidized, and a brownish or chocolate colored sediment is produced, most of which remains in suspension in the circulating system. Furthermore, the presence of air where the oil is so rapidly circulated as in a steam-turbine oiling system also results in an emulsion composed of air and oil.

How an Emulsion Is Formed

An emulsion is a mixture of liquids insoluble in one another where one is suspended in the other in the form of minute globules or a mixture in which solid particles of air are suspended in a liquid. In an oiling system in which the oil is rapidly circulated, an emulsion is easily formed on account of the mixture of the oil with either air or moisture, which reduces the lubricating properties of the oil and results in poor lubrication and the accompanying rise in temperature. One of the most common causes of trouble with steam-turbine lubrication is due to this emulsion of the oil with moisture or air, particularly if impurities (either solids or the products of oxidation) are present. The emulsion takes up dirt, particles of metal, products of oxidation and other foreign substances and holds them in suspension so that they cannot precipitate. Furthermore, a coating is deposited on the surface of the oil cooler medium, the rate of heat transfer from the oil to the cooling water is reduced, and an undue rise in the temperature of the oil results.

The products of oxidation, solids and other foreign substances which would ordinarily settle to the bottom if the oil were not so rapidly circulated, are commonly called "sludge," or "muck," and necessitate the cleaning of the oiling system of the turbine. The presence of this sludge, or muck, in the oil also reduces its lubricating value and is a frequent source of lubrication trouble. Solid impurities consist of such substances as core sand, iron chips and filings, rust, wood splinters, cotton waste, etc., which are generally found in a new turbine. It is evident that these substances must not be allowed to come in contact with the bearing surfaces because immediate abrasion would result. Furthermore, the full supply of oil to the bearings would be interfered with if these solids became lodged in the passages conducting oil to and from the bearings.

Breakdown of Oil May Be Caused by Electrochemical Action

The materials of which the various parts of a steam-turbine circulating system are composed, such as steel, iron, zinc, copper, etc., are of decidedly different potentiality and electrochemical action may take place, causing the oil to break down. It has been found that these chemical and physical changes produce an acid condition in the oil which will in time corrode the metallic parts of the turbine and eventually impair the smooth, clean bearing surfaces.

The moving parts of the governor in most steam turbines are lubricated with the same oil as used on the bearings, and in cases where the oil is in bad condition, the regulation of the turbine is affected owing to the governor not being able to move freely. In order to overcome this difficulty, force-feed lubricators have been installed on many steam turbines to effectively lubricate the governor.

Methods That Have Been Tried to Overcome the Difficulty

The combination of an effective circulating oiling system with the very best oil for the service is responsible for the greatest improvement in the lubrication of the steam turbine. However, owing to the fact that moisture and other foreign substances enter the oiling system and become mixed with the oil, it was found that some means would have to be provided to remove the foreign substances in order to keep the oil in proper condition. A number of methods for overcoming the difficulty were tried, and the following shows how, step by step, the successful solution of the problem was finally arrived at.

The first method tried was to add make-up oil. To make up for the amount lost by evaporation and leakage, oil was added occasionally, but it was found that even when the amount of new oil added was very small, a dark-colored deposit was thrown down, due to the action of the old oil on the new, and that all the oil in the system would in a short time become very dark in color, with a considerable increase in acidity.

The viscosity of the oil in the system was also increased as the new oil was of the same average viscosity as the oil originally put into the system, while the oil which was lost, owing to evaporation, consisted of the lighter parts of relatively low viscosity. This method does not overcome the results of rapid circulation nor provide for the removal of moisture, the products of oxidation or the accumulation of impurities, and eventually the turbine has to be shut down and the entire quantity of oil replaced by new.

To avoid the troubles due to simply adding make-up oil, "sweetening" was resorted to. This consisted in withdrawing from the turbine-oil reservoir a certain amount of oil periodically, depending upon the severity of the service, and adding enough new oil to replace the amount withdrawn and that lost by evaporation and leakage. This method was found but little more effective than the first method, as it was only a question of time before the whole charge of oil was unfit for use.

These two methods contain no provision for filtering the oil in order to keep it in good condition. "Batch filtration" was tried and found to be a pronounced improvement as the whole charge of oil in the system

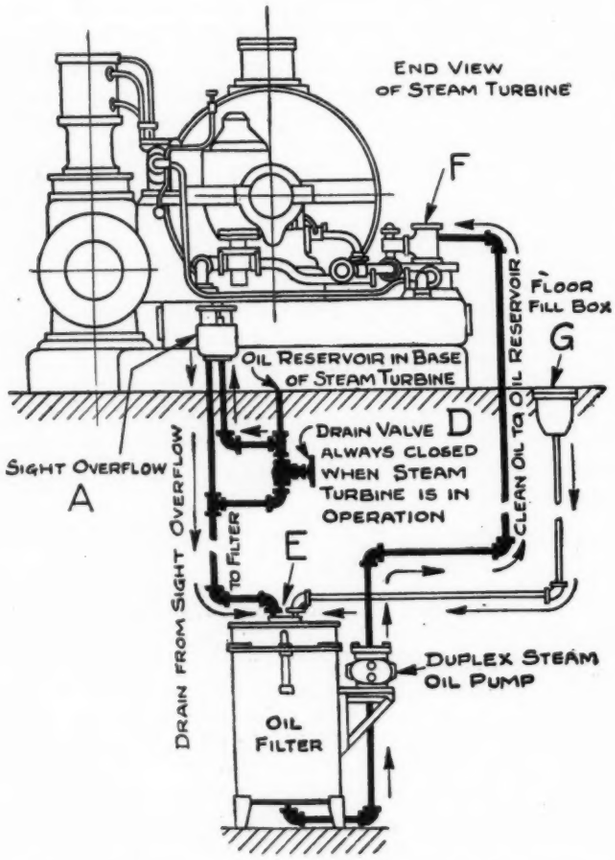


FIG. 2. CONTINUOUS BYPASS TURBINE-OIL FILTERING SYSTEM

is withdrawn and filtered before being used again, the turbine in the meantime having been filled with a charge of clean oil. There are several serious objections to "batch filtration," however; namely, it requires the unit to be shut down while withdrawing the dirty oil and refilling with clean oil; also, as the oil is not withdrawn until it becomes unfit for use, the turbine is compelled to run for a large part of the time on oil that is not in proper condition, and furthermore, it is dependent upon the judgment of the operator who decides when the oil should be withdrawn and filtered.

Continuous filtration was next tried. In this method the entire volume of oil is filtered each time it is pumped by the oil pump of the circulating system. This method is very effective and, for very small turbines where only a small quantity of oil is circulated, is the best method. For larger turbines, however, the expense of the necessary filter, filter oil pump and piping makes this method undesirable. Another objection is the great amount of space occupied by the filter and its accessories.

The Remedy for Trouble in Steam Turbine Lubrication

The experience gained with the methods described resulted in the development of the "continuous bypass" oil-filtering system, which maintains the lubricating oil in its original pure state by continuously bypassing a part (from 10 to 20 per cent) of the oil contained in the turbine oil reservoir; removing any moisture, air, solid impurities, emulsion, products of oxidation and any other impurities that impair the lubricating value of the oil, and returning the purified oil to the self-contained oiling system of the turbine. To filter the entire volume of oil each time it is pumped by the oil pump of the turbine circulating system would necessitate using very much larger sizes of filter, filter oil pump, and piping, which would materially increase the cost of the equipment. This additional expense is not warranted, as equally good results are obtained with the continuous bypass system. Steam turbines equipped with these systems have been in operation for a number of years, and the operating records show that the original oil was still being used, only enough having been added to replace the amount lost by evaporation and leakage, also that regulation was all that could be desired, indicating that the governor was being properly lubricated.

The continuous bypass oil-filtering system shown diagrammatically in Fig. 2, is extremely simple. It consists of a sight overflow through which the oil in the turbine reservoir flows by gravity to an oil filter which removes moisture and other foreign matter, and a filter oil pump which returns the clean oil to the turbine reservoir. The sight overflow is vented to prevent siphoning, and when being connected to the turbine, the level of its overflow pipe is set to correspond with the desired level of oil in the turbine reservoir, which level is thereafter automatically maintained at all times. This arrangement assures that the turbine-oil reservoir will always be full to the proper level as the quantity of dirty oil overflowing to the filter is balanced by the amount of clean oil delivered to the turbine reservoir by the filter oil pump. An accidental stoppage of the filter oil pump cannot in any way jeopardize the continuous operation of the turbine, as accidental draining of the turbine-oil reservoir is not possible with the vented sight overflow.

This system is the best insurance against lubrication troubles. In addition to its keeping the oil in proper condition, less work is required of each gallon of oil because the volume in use is increased by the additional quantity in the filter. Furthermore, this system makes it possible to use the oil over and over again indefinitely, thus the cost becomes an investment rather than an expense.

If a bearing on a new machine persists in heating and the operator is satisfied that the oil used is not too light or too heavy, then the bearing may be out of line, or designed with insufficient clearance. Overheating may also result when the clearance is too great and trouble may follow because the bearing has high and low spots upon its surface.

Utah Coals and the Fuel Supply of Salt Lake City

By OSBORN MONNETT

IN CONNECTION with a smoke-abatement investigation, a fuel survey of Salt Lake City was made to determine the amount of coal burned in the city, the amount burned by different classes of fuel users, the source of the coal and its characteristics.

The total amount burned in the city was arrived at in a preliminary manner by finding from the railroads entering the city the tonnage of commercial coal hauled into the city, and adding to this total railroad coal burned within the city. This amount gives the grand total of all coal consumed in the city and a figure to check against when determining the amount burned by the various classes of fuel consumers. The amount of coal used by the different classes of fuel consumers except for residence and domestic use was obtained by means of questionnaires sent to all coal consumers. The information obtained was tabulated under the following heads: Apartment houses, business houses, churches, cleaning and dyeing establishments, dairies, creameries, hotels, hospitals, industrial boiler plants, laundries, office buildings, central heating plants, public buildings, schools, residences and locomotives.

This article is taken from the smoke-abatement report of the Bureau of Mines, made as a result of its work in co-operation with Salt Lake City and the University of Utah. Published with permisssion of the Director, Bureau of Mines.

The coal consumed by residences was determined by a house to house canvass made by the Boy Scouts. This canvass also included a tabulation of domestic heating and cooking equipment. The coal consumed was distributed over the entire year by months. All of the information concerning coal consumption excepting in residences was supplied by months. In order to distribute the residence consumption by months, it was necessary to make some calculations. The coal used by plants which have a heating load only was distributed by percentage for each month and it was assumed that the residences which use coal principally for heating would use fuel in the same ratio, so the residence coal was distributed throughout the year in the same ratio as that used by strictly heating plants. The fuel oil consumed in Salt Lake City is a very minor quantity and amounted during the year of our survey to only 1,927,560 gallons.

The coke consumed in the city was also determined. This was a very small amount—3,470 tons for residence purposes and about 8,000 tons burned at the plant of the Utah Gas and Coke Co., the remainder of the coke produced being shipped out of the city. The source of the coal supplying the city coal market was obtained by questionnaires sent to all the coal operators who supply coal to that market. The coals were classified as to the particular locality from which they came. The coals in the same locality have about the same characteristics. Those classed as the Carbon and Emery County coals are from the group of mines in southwestern Carbon and northwestern Emery County. The Spring Canyon coals include all those mined in Spring Canyon. The Carbon County coals include all coals mined in Carbon County with the exception of those separately classed. The Grand County coals are those mined in Grand County. The Wyoming coals were all grouped into one class.

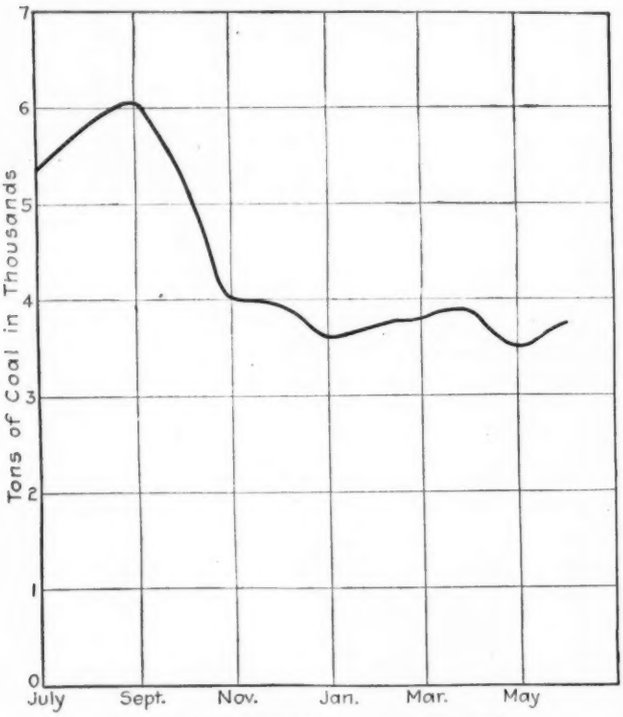
The characteristics of Utah coals was determined from a series of samples taken from railway cars and storage piles in yards of retail dealers. This gave the characteristic of the coal as delivered and used in Salt Lake City. The samples taken were sent to the Pittsburgh laboratory of the Bureau for analysis. Utah coals show a marked contrast to the general run of Western coals. The results of our analyses show them to be low in moisture, low in ash, with a high B.t.u. value. Their most pronounced characteristics

SALT LAKE CITY ON A SMOKY DAY
The need for smoke-abatement study is obvious.

are a high percentage of volatile matter and an extremely low sulphur content. These characteristics make a coal that is easily burned in all types of furnaces. The high volatile content produces a coal that is easily ignited, one that burns freely with a minimum production of clinker.

From the smoke standpoint the most pronounced characteristic of Utah coal is the volatile content. In general the higher the volatile matter in the coal the more smoky its performance. This is because of the difficulty of supplying sufficient air or oxygen to burn the volatile matter before it distills away from the fire and passes off through the boiler in the form of unconsumed carbon. Our experiments show that the standard methods of handling high-volatile coal as developed in cities of the Middle West are sufficient to burn the Utah coal smokelessly; that is, the headroom flame travel and other requirements for a successful furnace will satisfactorily handle coals on Salt Lake market.

Possible sources of anthracite available in Salt Lake City are: Pennsylvania anthracite, which, of course, is prohibitive in price; Colorado anthracite from Crested Butte, which is eliminated because of producing less than 20,000 tons per year and having abundant market

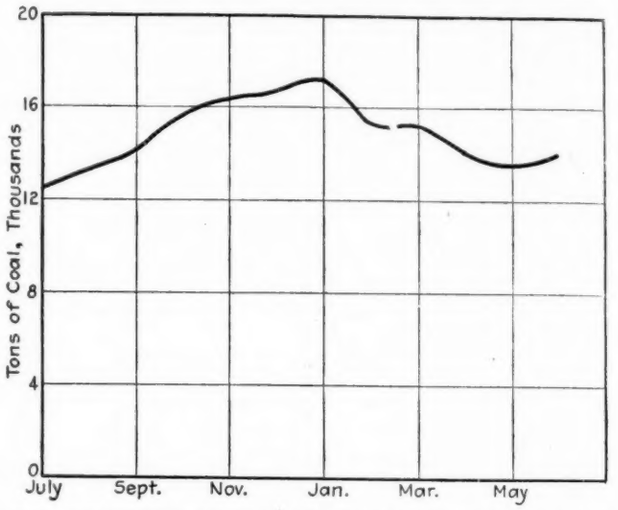


COAL CONSUMPTION OF RAILROADS

in Denver; Routt County anthracite; the proposed anthracite from Marble, Col., and a limited anthracite deposited at New Harmony, near Cedar City, Utah, in the southern part of the state. The latter three constitute the only source from which there is even a faint possibility of getting a supply of anthracite.

Engineers have spent considerable time examining the Routt County region for available anthracite and have reported adversely on this region because of the unreliability of the deposits in regard to continuity. Anthracite from this region, even if found in good quantity and of good quality, would have a prohibitive haul through Denver until such time as additional railroad facilities are provided through northern Utah.

Glenwood Springs (Marble Region, Col.) coal is situated about four miles from the Marble Glenwood Springs R.R., and samples analyze as of a fair grade of anthracite. Mining interests have regarded this deposit as inaccessible by ordinary means of transportation, which, coupled with the fear that the deposit would prove unreliable in extent, has retarded development.



COAL CONSUMPTION OF INDUSTRIAL POWER AND LARGE HEATING PLANTS

From information available there seems to be a fairly large acreage available with seam pitch of about 60 deg., and there would be about 600 or 800 ft. of ground available above the level at which the coal would be intersected by a feasible tunnel. In the proposed development of this property it is planned to bring the coal to the mouth of the tunnel by ordinary mining methods and thence over a very high, rough country by three to four miles of aërial tramway.

Assuming that the coal is dependable anthracite of good quality and abundant tonnage, the proposition would not offer an immediate solution of Salt Lake's fuel problem; with a pitch of 60 deg. it would take extensive development before sufficient ground could be opened to give a thousand tons per day, while this amount of tonnage transported over an aërial tramway would offer problems, especially in the winter season, which, to say the least, would be difficult in the extreme.

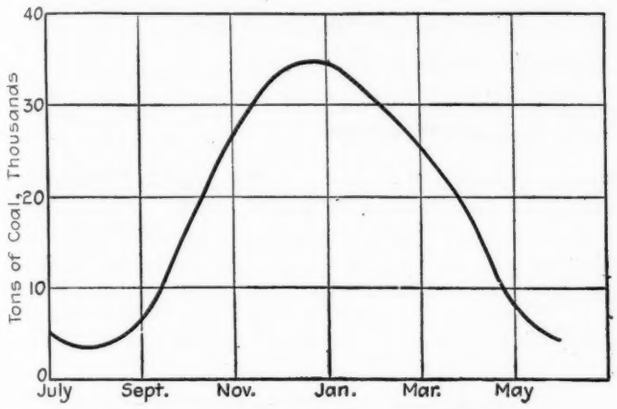
Briquets and Coke

(a) Briquets—Prepared fuel in the shape of briquets would offer a solution of the domestic problem if manufactured under proper conditions. Some Western coals, including lignites, have been prepared in briquet form by driving off the moisture and part of the volatile matter and producing a fuel that is smokeless for domestic purposes.

Briquetting has not as yet come into extensive use in the United States. The possibility of smokeless briquets for the Salt Lake market is one that should be considered only as a future possibility. Any process of briquet making with native coals that would include a partial carbonization, might more advantageously use coking methods, which would recover a larger percentage of byproducts.

(b) High-temperature Coke—An attractive solution of the domestic smoke problem is to be found in the burning of coke. The manufacture of coke for

residence purposes would not only be a means of eliminating the domestic smoke nuisance, but would also be a step in the conservation of natural resources. The time is not yet ripe for the use of coke in industrial plants, although it seems likely that in the course of a

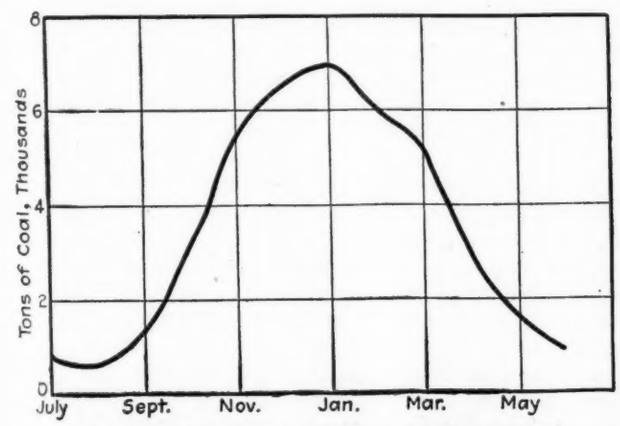


COAL CONSUMPTION OF RESIDENCES

few decades no coal will be burned before carbonization and recovering of the valuable byproducts.

Coking processes fall into two general classes—high-temperature processes and low-temperature processes. In the first class, coal is carbonized at a temperature of from 900 to 1,200 deg. C., producing a coke with very low-volatile content which is correspondingly difficult to ignite. The low-temperature process now being given considerable attention by engineers proposes to carbonize coal at temperatures of 450 to 600 deg. C. and produce a coke with higher volatile content and one that can be more readily ignited.

To supply the present needs of Salt Lake City 210,000 tons of coke would have to be produced annually. This would necessitate the carbonization of about 350,000 tons of coal and would produce nearly 4,000,000,000 cu.ft. gas, 3,500,000 gal. tar and 4,000 tons ammonium sulphate. There are about 15,000 tons of gas coke available yearly in Salt Lake City, most of which is

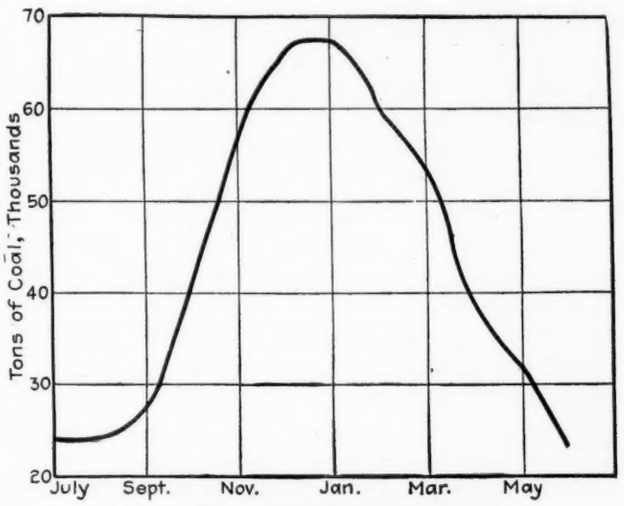


COAL CONSUMPTION OF SMALL HEATING PLANTS

shipped out of the state. A small number of residents have burned this coke for years with satisfactory results. Steps should be taken to bring about the consumption of all this coke in Salt Lake City.

(c) Low-Temperature Coke—During the last ten years increasing attention has been given to the possibilities of low-temperature carbonization. A low-temperature coke is one containing sufficient volatile matter to make a fuel that ignites and burns readily. When coal is carbonized at temperatures of 450 to 600 deg. C., coke and byproducts differing in nature and amount from those produced by the high-temperature process are obtained. The coke still contains from 8 to 16 per cent of volatile matter and is more suitable for domestic use. It ignites readily, somewhat similar to semi-bituminous coal, burning without smoke. The smoke-producing constituents have been decomposed and driven off during the carbonization process.

The tar produced in such a process is a thin fluid better called an oil. It is produced in twice the quantity given in high-temperature carbonization. It contains considerable quantities of motor fuel, burning and lubricating oils, a small amount of pitch and 20 to 40 per cent cresols and other phenols. The gas is produced in smaller amount, but is of high calorific value. One



TOTAL COAL CONSUMPTION OF CITY

ton of coal carbonized at a temperature of about 450 to 600 deg. C. will give 1,300 to 1,500 lb. of coke, 2,000 to 7,000 cu.ft. of gas, 20 to 30 gal. of tar and 2 to 8 lb. of ammonium sulphate.

(d) Disposal of Byproducts—Disposal of the gas produced offers the most difficult problem in the operation of a high-temperature carbonizing plant at Salt Lake City. Tar and ammonia can be sold at points some distance away. Gas must be consumed as soon as produced and sold in or near the city.

As before shown, a plant of sufficient size to supply a high-temperature coke to domestic consumers in the city would produce nearly 4,000,000,000 cu.ft. of gas. Salt Lake City uses at present about 420,000,000 cu.ft. of gas, or about one-tenth of the amount produced by a plant of the size mentioned. Part of this gas might be used in carbonizing the coal, but disposal of the remainder would be a difficult matter, necessitating the selling of the gas at a low rate for industrial and domestic purposes and holding down the production of coke for many years while the demand for gas was being built up.

Low-temperature carbonization produces about one-third as much gas, practically all of which can be used in the carbonization process itself. In this respect low-temperature carbonization seems the more feasible.

Electric Welding Machines—Direct-Current Constant-Current Types

Wiring Diagrams Are Given of Various Types of So-Called Constant-Current Welding Machines, and the Operation of the Machines is Explained—Comparisons are Made of the Different Methods of Control

By L. W. WEBB
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IN ORDER to do away with the resistance losses necessary with the constant-potential type of welding machines and provide single-operator sets as efficient and as light as possible consistent with reliable operation, etc., there have been developed various equipments of the so-called "constant-current types." A diagram of a United States Light and Heat Co.'s arc-welding converter is shown in Fig. 1. This type of machine combines in a single structure the functions of a motor and generator. Conversion of direct current from 120-volt supply to a lower voltage suitable for the arc is accompanied by small losses and therefore has a high efficiency from the standpoint of power input to energy delivered at the arc. This efficiency, of course, is obtained when machines are used upon existing 120-volt direct-current installations. When it is necessary to supply a separate motor-generator set to obtain 120-volt current for the operation of one or more machines, then the combined efficiency of the whole is not as good as that of the motor-generator type, which can have its motor designed to operate from any existing circuit.

The reactance coil is constructed to have two independent windings so they can be connected in series to give high reactance on low welding currents and in parallel to give low reactance on high welding currents. This equipment has the disadvantage of requiring special 120-volt direct current and also, unless the

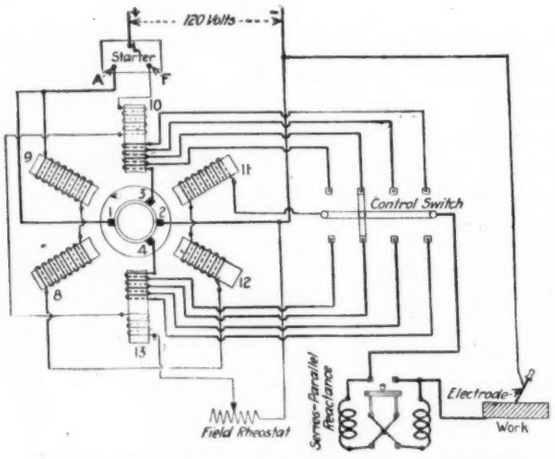


FIG. 1. DIAGRAM OF ARC-WELDING CONVERTER

circuit is insulated from the ground, there is always the danger of a ground coming on one side of the line or other separate circuits or devices, causing a short-circuit of a part of the armature. Or possibly one side of the line had a ground on it before the machine was connected, and upon attempting to connect for operation caused a short-circuit when grounding to the work. However, where the work can be insulated from the ground this disadvantage does not exist.

As seen from Fig. 1, six poles are provided, but four of them are so wound as to produce a magnetic flux in the horizontal axis, constituting, therefore, a bipolar field. The main poles are provided with two windings, one a shunt winding connected across the source of

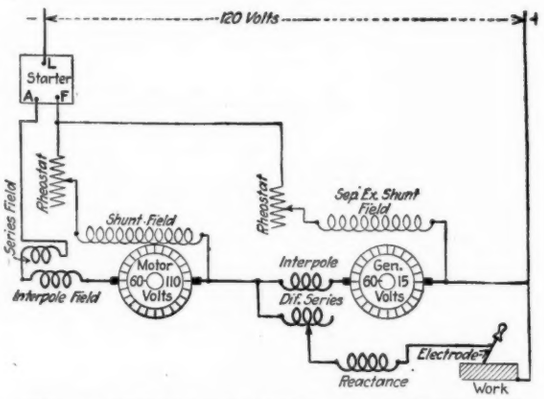


FIG. 2. ROTARY-BALANCER SET CONNECTIONS

supply, and a series winding in two parts connected between brushes 3 and 4 and a common terminal. The series winding is so arranged that more or less turns of these coils may be introduced or withdrawn from the circuit by a control switch. The current supplied to the welding circuit is furnished in equal portions by brushes 3 and 4. This current passes through the series winding and unites at a common point on the control switch, thence through the reactance, the welding arc, and back to the negative line connected to brush 2. The voltage existing across brushes 3 and 4 and brush 2 depends upon the direction and degree of excitation of the two main poles. On open-circuit this voltage is approximately 60, which is automatically reduced to an arc voltage of 20 by the action of the current flowing through the differentially wound series windings. The coils constituting the armature winding of this converter are placed in slots approximately 120 deg. apart and are effective in either the two-pole or the four pole field. The current supplied through the complete armature winding from brushes 1 and 2 and operating in the bipolar field on the horizontal axis forms the motor function. The current supplied to the welding circuit from portions of the armature winding through brushes 3 and 4 and brush 2 results from the generator action and depends for its final value upon the direction and magnitude of the right-angle components of the flux produced in poles 10 and 13 on the vertical axis of the armature. Control of this machine is simple, and adjustments

of the various current values are easy to obtain. It is very compact, and for this reason can be taken in places where an ordinary motor-generator type of machine could not be placed.

Fig. 2 is a wiring diagram of the General Electric

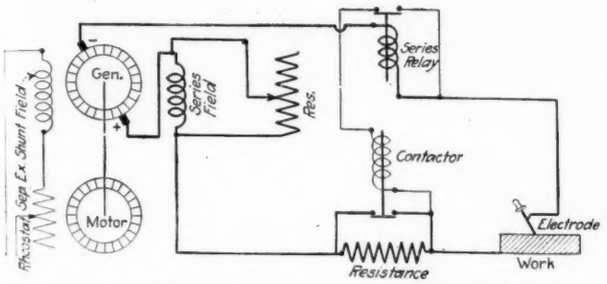


FIG. 3. ARC-WELDING MOTOR-GENERATOR SET CONNECTIONS, HAVING CONTACTOR TO SHORT-CIRCUIT RESISTANCE

Co.'s rotary balancer set. This set operates with an external reactance having a fixed value for all currents. As can be seen from the diagram, this is a motor-generator type of machine, but owing to the way in which it is operated it offers certain advantages in being light, compact and easily portable. This equipment is also capable of wide variations in the welding-current control, and these adjustments are easily made by the shunt-field rheostats, and a dial switch, the latter varying the number of series-field turns on the generator. The set is self-regulating to an extent that the short-circuited current at the moment of striking the arc does not exceed 25 to 40 per cent above normal. Its disadvantages, however, are that its use is limited to one certain voltage, 120, also that it is necessary to ground the positive side of the line to the work. As regards insulating the work and the efficiency of the set, the same may be said as for the aforementioned type.

A wiring diagram for a C & C Electric and Manufacturing Co.'s motor-generator is given in Fig. 3. This type of machine consists essentially of a generator with a differentially wound series field and separately excited shunt field. The machine is designed so that the welding current flowing through this differentially wound series field opposes the ampere turns of the separately excited shunt field, which reduces the no-load voltage from approximately 60 to a value sufficient to maintain the arc at approximately 20 volts. Current ranges varying from 80 to 200 amperes can be obtained, and proper voltage automatically maintained at the arc for welding within the foregoing limits. Welding-current adjustments are made by regulating the separately excited field and also by shunting a part of the current around the differentially wound series field. There is supplied a resistance in series with the welding circuit which is automatically cut in at the moment the arc is struck and short-circuited when the electrode is raised. No external reactance is supplied since the necessary reactance is provided in the design of the series-field winding and the magnetic circuit of the armature. The design of the machine is such that while the arc is flexible it cannot be drawn out too far, or to such a point where dependable welding cannot be done. The over-all efficiency of this machine is approximately 65 per cent at normal output. Also the motor may be designed for use on any circuit available and the welding operation is entirely separate and distinct, electrically, from the power supply. When these machines are driven by alternating-current motors it is necessary to provide a separate exciter to take care of the shunt-field winding, but when they are driven by direct-current motors this is unnecessary.

The wiring diagram, Fig. 4, is for another type of equipment having a separately excited shunt-field winding and a differentially wound series field; the latter causes the open-circuit voltage to be reduced from approximately 65 to 20 volts at the arc under normal welding conditions. This equipment is built by the Lincoln Electric Co. Adjustments are made by rheostatic control of the shunt field and also by shunting part of the current around the series field. An external reactance or stabilizer is furnished which enables the operator to maintain a stable arc easily. Currents varying from 80 to 200 amperes can be obtained by adjustments of the separately excited field and shunting of the series field to maintain the current as set practically constant during the welding operation. The over-all efficiency of these machines is approximately 48 per cent, and as the motor can be designed for operation from any circuit the set is more efficient than the constant-potential machine. At the moment of striking the arc the action of the differentially wound series field is such that the short-circuited current is held

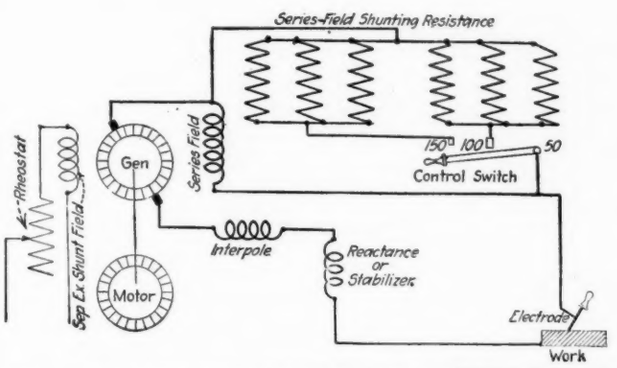


FIG. 4. WELDING EQUIPMENT HAVING DIFFERENTIALLY CONNECTED SERIES-FIELD WINDINGS

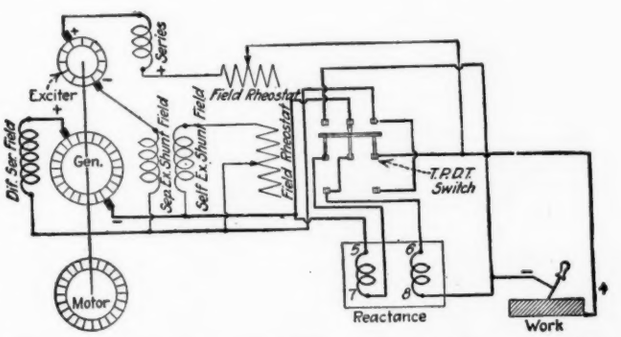


FIG. 5. WELDING EQUIPMENT HAVING TWO DISTINCT SHUNT WINDINGS AND SEPARATE EXCITER

down to about 140 per cent of normal, no external resistance being required. The only overload protection necessary is fuses on the motor circuit. When driven by alternating-current motor the machine requires a separate exciter.

A wiring diagram of the Siemund-Wenzel Electric Welding Co.'s motor-generator is that given in Fig. 5. Two separate and distinct types of shunt-field windings are used, one excited from a separate exciting circuit and the other self-exciting from the generator armature. The separately excited field can be adjusted so that when the machine is short-circuited at the instant of striking the arc it gives certain definite current values which determine the welding current, and as the electrode is lifted the additional excitation produced on the self-excited field provides regulation for the welding current. These machines are provided with external reactance wound in two circuits, and for the lower welding currents of 75 amperes and less the reactances are connected in series, thus giving high reactance values; and on the higher current values these reactances are paralleled, thus materially decreasing the total amount of reactance in the welding circuit.

The over-all efficiency is approximately 60 per cent. A separate exciter is necessary when the machine is driven by alternating-current motors, but is not required when driven by direct-current motors. The control, however, is not very simple, as proper operation depends upon the correct setting of two separate field rheostats, either one of which being incorrectly set would make the welding operation somewhat unstable. This, of course, would not apply if operators had been properly instructed or were experienced.

Fig. 6, which is a diagram of a Burke Electric Co.'s welding motor-generator, is somewhat similar to that in Fig. 5, the main difference being that in the latter there is supplied a differential series winding on a part of each pole, which is used as a compensating winding and which acts to oppose the shunt fields and maintain proper arc voltage. The separately excited field is adjusted so that when the electrode is short-circuited on the work proper welding current will flow, and as the electrode is lifted the adjustment on the self-excited field is so made that the generator armature voltage

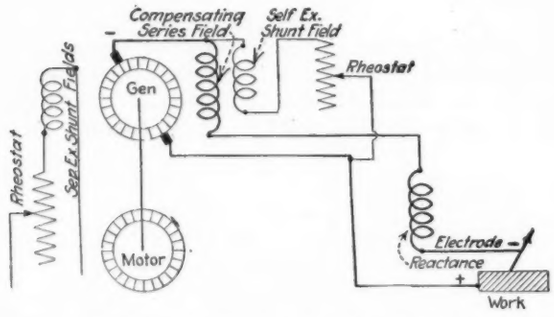


FIG. 6. WELDING GENERATOR HAVING TWO SHUNT WINDINGS AND A DIFFERENTIAL SERIES WINDING

will maintain proper welding current with 20 volts at the arc. The over-all efficiency of these sets is approximately 63 per cent. The motor can be designed for any voltage or frequency, and if direct current is used an additional exciter is unnecessary. Welding adjustments, however, as in Fig. 5, are somewhat difficult to make, as they depend upon the adjustment of two separate field rheostats, either one of which being improperly adjusted would make the welding somewhat unstable.

The wiring diagram, Fig. 7, is for a Westinghouse Electric and Manufacturing Co.'s machine and has some unusual connections. It is essentially a four-pole machine with four interpoles. On poles 1 and 3 there are shunt windings connected in series through a fixed resistance *A* and a variable resistance *B* across an external exciter. Poles 2 and 4 have differentially wound series fields, and paralleled shunt windings connected in series with a fixed resistance *X* and across the generator armature. The fixed resistances *X* and *Y* are directly connected across the exciter circuit, and their

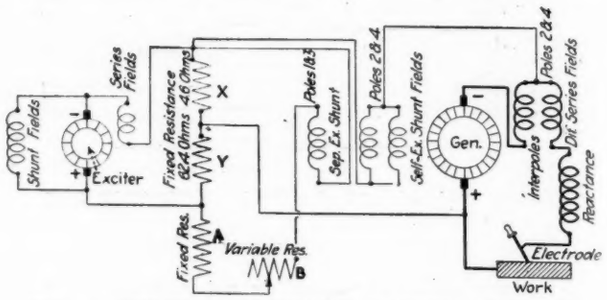


FIG. 7. WELDING GENERATOR HAVING A SPECIAL REGULATING FIELD WINDING

common connection goes to the positive side of the generator circuit. When the generator is operating under no load—that is, with the welding circuit open—and also during normal welding conditions, the current through the self-excited shunt field is obtained from the generator. During these periods the parallel shunt field is assisting the separately excited shunt field. At the instant the arc is struck the current for the separately excited shunt field comes from the exciter through the fixed resistance *Y* to the work, through the generator's series windings through the shunt windings 2 and 4, in the reverse direction, and back to the negative terminal of the exciter. From this it is seen that when the machine is short-circuited at the instant of striking the arc the excitation of fields 2 and 4 immediately drops to zero and reverses momentarily, so that the current then flowing is that due to the amount of excitation furnished by the separately excited fields minus the bucking effect of the reverse current in the multiple shunt fields and the current flowing through the differentially wound series fields. When the electrode is lifted and welding started, the excitation then furnished to the self-excited fields by the generator provides an amount just sufficient to maintain current under proper welding conditions of 20 volts at the arc.

The different welding currents are obtained by a variable rheostat *B* in the separately excited field, and welding-current changes can be obtained variable between 50 and 200 amperes. There is a fixed reactance supplied in the external circuit, which also helps to hold down the short-circuited current at the instant of striking the arc, as well as stabilizing the arc. On machines, whether driven by direct- or alternating-current motors, it is necessary that a separate exciter be furnished to provide the special control shown by the wiring diagram. These exciters normally supply about 125-volt direct current and are compound-wound.

The machine is adapted for portable welding use and has an over-all efficiency of approximately 53 per cent. One point, however, which should be mentioned is the fact that if either one of the resistances *X* or *Y* becomes open, burned out, etc., and is repaired by the ordinary repair man he would very likely change their

resistance values without giving it much thought—in order to make rapid repairs, as is ordinarily done, without ordering new resistances from the factory. This means that the entire machine-welding characteristics would be changed, and with the chance of damage to the whole equipment.

Regulation of the United States Light and Heat Corp. motor-generator, schematic wiring diagram, Fig. 8, unlike those described in the foregoing, is obtained without the use of any separate exciter and is termed the "variable-voltage self-regulating welding type," rather than the so-called "constant-current type," although it is capable of supplying current ranges from 80 to 200 amperes under welding conditions similar to the other type described. The windings on this machine consist of a self-exciting shunt winding, which magnetizes the field poles to a low point of saturation.

The action of the light cumulative-compound winding upon the field flux results in maintaining a stable current under welding conditions as set by the adjustments of the shunt-field rheostat and the series shunt around the compound winding. At the instant the electrode is shorted the current flowing is due to the flux produced by the compound winding and the small amount of flux set up by the shunt field, produced by the low voltage across the generator armature. As the electrode is lifted the shunt-field current increases, which provides proper values of flux for the welding current desired. Variations of welding currents are obtained by adjusting the shunt-field rheostat and the shunt across the series-field winding. Separate and external reactances furnished in these circuits enable the operator to maintain a steady arc. Owing to its not being necessary to have any separate exciter with this machine, it is simple and efficient in its operation. The open-circuit voltage is approximately 60 volts, and the over-all efficiency is approximately 60 per cent.

Regulation of the General Electric Co.'s motor-generator, Fig. 9, is similar to that in Fig. 8 and is also ob-

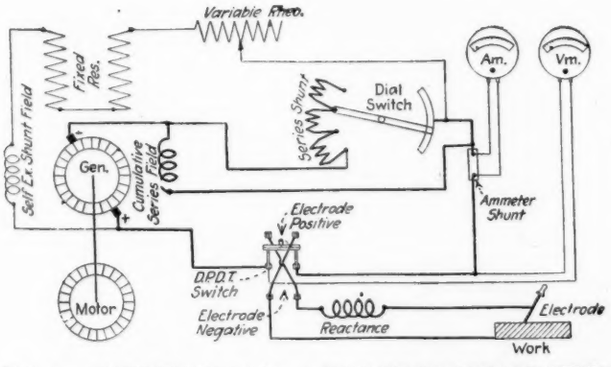


FIG. 8. CONNECTIONS FOR A VARIABLE-VOLTAGE SELF-REGULATING TYPE OF WELDING EQUIPMENT

tained without the use of any separate exciter, whether driven by direct-current or by alternating-current motors. This machine is termed the "constant-energy self-excited type," rather than the "constant-current type," although it is capable of supplying current ranges from 75 to 200 amperes under welding conditions. As can be seen from the wiring diagram, this machine has shunt windings on four poles connected to one side of the line through a variable rheostat and to a special third brush on the commutator, so set as to supply voltage for the shunt-field excitation required for the various welding currents. On two of these poles there are series windings connected in parallel, with taps also connected in parallel. The number of series turns is controlled by a dial switch, thus providing the means for obtaining various welding currents in combination with the rheostat adjustments of the self-excited field. The open-circuit voltage of this machine is approximately 60 volts, which automatically drops to 20 volts while welding is being done. An ex-

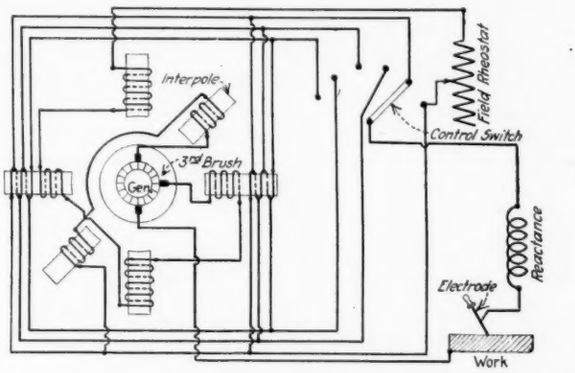


FIG. 9. CONSTANT-ENERGY SELF-EXCITING TYPE OF WELDING-EQUIPMENT CONNECTIONS

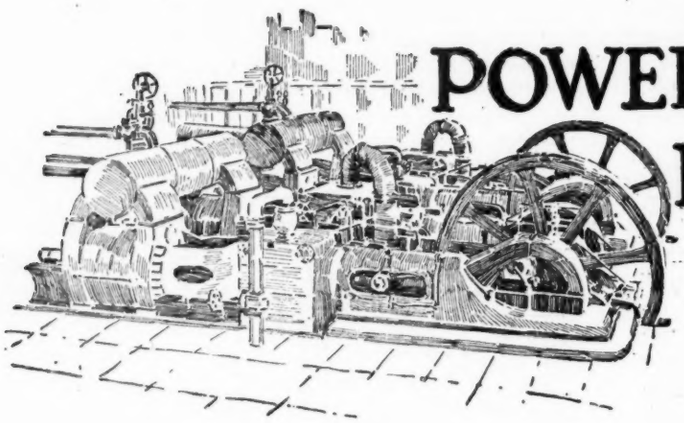
ternal reactance of the fixed type is provided which assists to hold down the short-circuit current at the instant of striking the arc and also provides a sufficient amount of reactance for stable conditions during welding. The maximum short-circuited current is approximately 250 amperes. This machine has an over-all efficiency of approximately 53 per cent.

(In the previous article constant-voltage welding equipments were treated of. The next article will be a general discussion of welding machines and the reactance values that are required in the circuit in order to do good welding.)

Injury from Engine in Power House

Pumping machinery, inclosed in an iron house at the Little Pirate Oil and Gas Co., Kansas, which was operated and taken care of by an employee, was allowed to run for a short time when he left the plant to attend to another task. The home of his family was within one hundred feet of the power house, and while he was absent, his son, 12 years old, accompanied by another younger son, entered the power house to shut off the engine. The latter went so close to the machinery that he was caught in a belt and suffered injuries which resulted in his death. The children had been repeatedly warned by employees of the danger of close approach to the plant and directed to keep away from it.

Suit for damages was brought against the company by the father of the child, and the decision of the court was to the effect that "if there was any want of care in the premises, it was chargeable to the plaintiffs themselves. They had control and management of the power plant and also the care and control of their children. The defendant could not be expected to supersede the plaintiffs in the direction and guardianship of the children, and neither can it be held responsible to them for their own inattention nor lack of care."



POWER DRIVES FOR ROLLING MILLS

By

W. O. Rogers

Large quantities of water are used for boiler feeding, but in many instances it is necessary to treat it chemically. This is especially true of the Mahoning River water, and large treating systems have been installed in several of the rolling mills in the Youngstown district.

WATER FOR feeding boilers is an important factor in steel-mill operation. The two big plants of the Republic Iron and Steel Co., and the Youngstown Sheet and Tube Co. are located on the Mahoning River, into which the sewage from the City of Youngstown and wastes from all manufacturing plants between that city and Warren, Ohio, are discharged. The impurities so introduced, in addition to the normal hardened condition of the water, make it undesirable for boiler feed without treatment. Analyses of the river water before softening and precipitation with analyses of the water after being softened are shown in the accompanying table. The softened water shows the absence of the sulphates, chlorides and nitrates of lime, iron and magnesia, and also that the total of the residual lime as calcium carbonate and the residual magnesia as magnesium hydroxide is less than two grains per gallon. A plant capable of treating 300,000 gal. of water per hour, or 7,200,000 gal. per 24 hours, and laid out so that a 25 per cent extension can be made increasing the treating capacity to 375,000 gal. of water per hour, or 9,000,000 gal. per 24 hours, is in operation at the Republic works, and one with a capacity of 5,000,000 gal. of water per day at the Youngstown plant. Water softening is the chemical removal of soluble impurities that makes water hard, but in order to determine the proper chemicals and the amount, the water must be analyzed to ascertain the impurities. Before soluble impurities can be taken from water, they must be made insoluble so that they can be removed by sedimentation and filtration. To soften water, it is necessary to remove both its temporary and its permanent hardness. The temporary hardness is caused by the carbonates of lime, magnesia and iron, which are held in solution as bicarbonates. The permanent hardness is caused by the sulphates, chlorides and nitrates of lime, magnesia and iron.

Generally, but two reagents are required for water purification. What makes the difficulty is the fact that the impurities in the water are small and are frequently made up of several substances, each of them differing in the time and quantity of reagents required for reaction. Lime and soda ash are the reagents usually employed, but these are frequently supplemented by other reagents in order to obtain the best results. When feed water containing soluble hardening substances is introduced into a steam boiler, the impurities are eventually forced out of solution and are deposited either as a sludge or as a scale, so familiar to steam engineers. It is known that a clean boiler will evaporate more water per pound of coal than one that is coated with scale. The presence of scale also causes overheating, and an overheated boiler plate is more readily attacked by corrosive agents than one that has not been overheated and weakened. Furthermore, in the modern power plant the boilers are operated up to around 250 per cent of rating, and at the higher rate of evaporation the amount of concentration of impurities in the water in the boiler increases. At the Republic

FIG. 1. MIXING AND SETTLING TANKS

Works the intermittent type of purifier was installed, because the water of the Mahoning River could be treated in fixed volumes and a water obtained that is uniformly softened regardless of variation of the condition of the river.

In the intermittent system definite quantities of water are treated all the time, the exact quantities of the

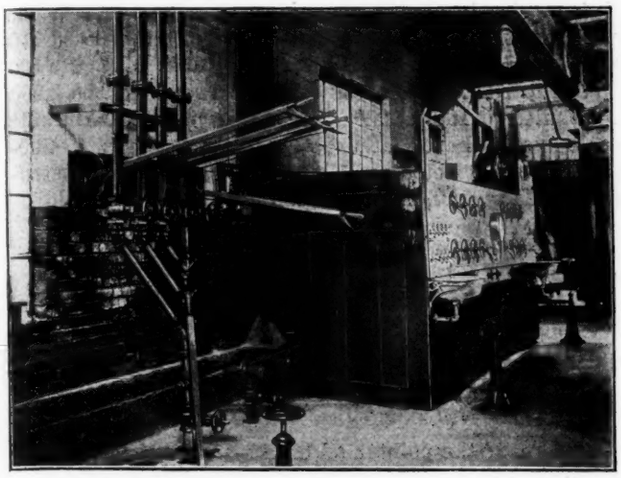


FIG. 2. OPERATING BOARD FOR CONTROLLING MIXING AND SETTLING TANKS

reagents required being weighed out so that each tank of water is properly treated.

The reaction tanks are filled alternately with water. While the tank is filling, the reagents are introduced and mixed with the water by means of a stirring apparatus. After the tank is filled, the stirring is stopped and the water becomes static. This allows the precipitate to settle. The softened water is taken out

MAHONING RIVER WATER—RAW AND TREATED

Grains per U. S. Gallon

	Raw	Treated	Raw	Treated	Raw	Treated
Volatile and org. matter...	1.15	0.65	0.95	0.75	1.05	0.65
Silica	0.45	0.45	0.75	0.75	0.75	0.45
Oxides of iron and alum...	trace	trace	trace	trace	trace	trace
Calcium carbonate	2.43	0.88	2.80	0.60	3.20	0.80
Calcium sulphate	11.32	....	5.03	....	3.94	....
Magnesium sulphate	4.86	....	3.84	....	2.88	....
Magnesium hydroxide	....	0.48	....	0.17	....	0.23
Sodium carbonate	....	2.78	....	2.12	....	2.00
Sodium sulphate	0.53	18.46	4.40	15.05	0.85	8.95
Sodium chloride	9.40	10.22	2.45	2.57	2.22	2.34
Sodium nitrate	....	....	trace	trace	0.17	0.17
Sodium hydroxide	....	0.94	....	1.36	....	0.64
Manganese carbonate	0.08	....	....	....	....	....
Total solids	30.22	34.86	20.22	23.37	15.11	16.23
Suspended matter	0.65	trace	0.45	filtered out	1.45	trace
Free carbonic acid	0.25	none	none	none	0.25	none
Incrusting solids	19.14	1.81	12.42	1.52	10.82	1.48
Non-crusting solids	9.93	32.40	6.85	21.10	3.24	14.10

near the surface, where it is cleanest and carries the least floating sludge, by means of a float arrangement and is then discharged to the filter bed.

There are eight steel reaction and settling tanks at each of the two plants mentioned, those at the Republic plant being 37 ft. in diameter and 35 ft. high, arranged in two parallel rows with four tanks per row. Fig. 1 shows the mixing and settling tanks that are used for filtering the boiler-feed water at the main plant of the Youngstown Company. Fig. 2 shows the operating board for operating the mixing and settling tank, on which is mounted the control handle. At the ends of the control board there are open mercury gages for indicating the height of water in the tank. These are shown in Fig. 3. A recording thermometer placed in the center of the board records the temperature of the water.

A view of the soda ash and lime-mixing tanks is shown in Fig. 4. The stirring apparatus is driven by means of belts that run through the floor to a shafting that is motor-driven, a friction clutch on each tank permitting of starting and stopping each one independently of the other. The charges of reagents are weighed out and dumped in the reagent mixing tank, whence the charge is pumped into either one of the reaction tanks by means of motor-driven centrifugal pumps in a pit below the floor of the mixing tank.

The lime is slacked ready to be introduced into the reaction and settling tanks when the filling of the tank begins. As soon as the filling begins, the charge of lime is pumped into the tank and the stirring apparatus is started and is kept in operation during the period of filtering. When the tank is full, a charge of ferrous sulphate is introduced, and after a lapse of about ten minutes a sample of water is taken for testing the correctness of the lime treatment and the ferrous sulphate.

After the introduction and mixing of the ferrous sulphate, a charge of soda ash is put in and stirring is continued for about fifteen minutes. Then the water is allowed to stand for reaction and settling. One-half hour after stirring is stopped, a sample of the fully treated water is drawn for testing. At the end of the settling period the water is delivered to the filters as required. The filters are equipped with individual air-washed systems, consisting of brass laterals drilled for the uniform distribution of air. This piping is placed above the strainer piping in the filter bed. The filter removes the crystalline precipitate that is too fine to settle and guards against the possibilities of dirty water from the settling tanks getting into the boiler-feed system.

When I left the rolling mills, I was more impressed with their bigness than I had ever been before. The

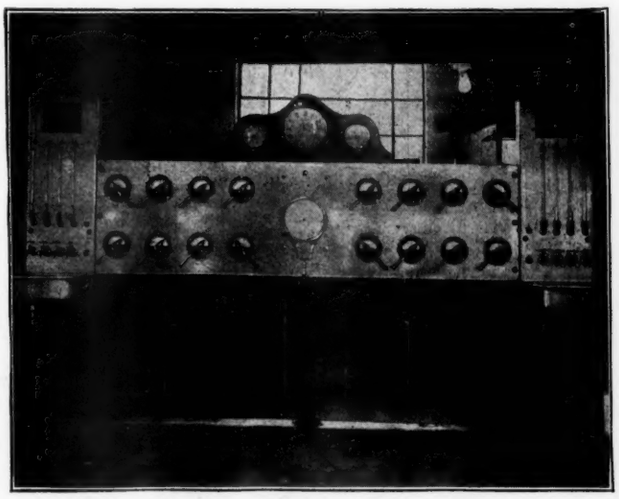


FIG. 3. FRONT VIEW OF THE OPERATING BOARD SHOWING MERCURY GAGES AT EACH END

sizes of some of the units, both engines and motors, were impressive, as was also the area covered by the mills as a whole. It was not possible to obtain permission to go through many of the steel mills such as those in the Pittsburgh and Cleveland districts, but enough large mills were accessible to enable me to obtain

FIG. 4. SODA-ASH AND LIME-MIXING TANKS

sufficient data and illustrations to convey to the reader an idea of the general process of making steel and also of the types of machines and equipment used in its manufacture.

Checking Single-Phase Wattmeters

By H. C. Yeaton

Like all switchboard instruments, a single-phase indicating wattmeter should be checked frequently to ascertain that it is indicating correctly. The wattmeter can be checked with a portable single-phase instrument, and the accompanying diagrams of connections and instructions explain, in general the procedure:

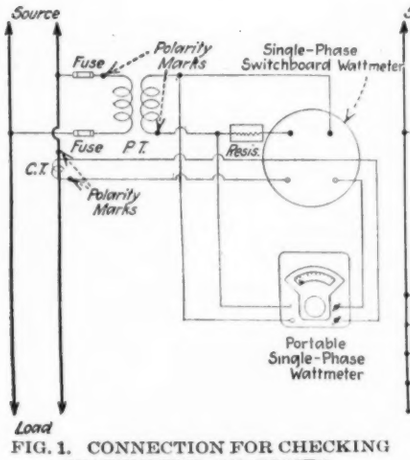


FIG. 1. CONNECTION FOR CHECKING WATTMETER IN POWER CIRCUIT

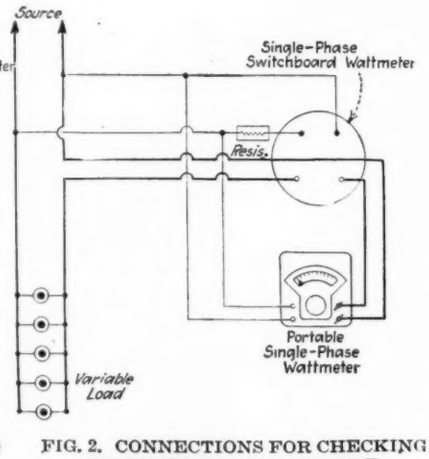


FIG. 2. CONNECTIONS FOR CHECKING WATTMETER ON VARIABLE LOAD

Connect the single-phase portable wattmeter in the circuit as shown in Fig. 1, the current terminals of the portable wattmeter being connected in series with the current terminals of the switchboard instrument, and the potential terminals of the portable instrument being connected across the potential circuit. The scale of switchboard indicating wattmeter is usually marked in primary watts—that is, the actual watts or kilowatts of the circuit—and is equal to the primary amperes multiplied by primary volts. This scale is marked so that it can be easily read, and it generally ends in an even number. The calibrating watts of a single-phase wattmeter is the watts required to make the needle deflect from zero to full scale, and equals the scale range divided by potential-transformer ratio multiplied by current-transformer ratio, when transformers are used. By checking the calibrating watts of the switchboard wattmeter with the portable wattmeter, the accuracy of the former may be determined.

Suppose that the single-phase system shown in Fig. 1 is a circuit of 100 amperes and 2,200 volts. The potential transformer has a ratio of 20:1 (2,200 to 110 volts) and the current transformer ratio is 20:1 (100 to 5 amperes). The watts of the circuit would be 2,200 multiplied by 100, or 220 kilowatts, but as a 220-kilowatt scale would have rather an uneven ending, a 200-kilowatt scale would probably be marked on the instrument. Therefore, full-scale calibrating watts would be

$$\frac{200{,}000}{20 \times 20} = 500 \textit{ watts}$$

If the pointer of the switchboard instrument read 150 kilowatts, then the calibrating watts for this point would be

$$\frac{150{,}000}{20 \times 20} = 375 \textit{ watts}$$

Therefore, if the pointer of the switchboard wattmeter indicated 150 kilowatts, it would mean that only 375 watts were actually impressed on the instrument itself, and the portable wattmeter, also being connected on the secondary of the transformers, would indicate 375 watts if the switchboard wattmeter was indicating correctly.

The foregoing method of checking a single-phase wattmeter compares only one point on the scale, as it would not be convenient to vary the primary load, which would probably be a feeder circuit. For general checking, this method would be sufficient to obtain the approximate accuracy of a wattmeter.

If it is desired to check more than one point on the wattmeter scale, short-circuit the current transformer and disconnect the instrument from the circuit. Then connect the instrument on a single-phase circuit, using a variable load, so that different readings on the scale may be obtained, as in Fig. 2. For the switchboard meter the calibrating watts of any reading is determined as in the foregoing method, and by varying the load, any point on the instrument's scale can be checked with the portable meter.

Suppose that it is required to check the previous instrument at the points 50, 100, 150 and 200 kilowatts. Connect the instrument on a 5-ampere 110-volt circuit, as shown in Fig. 2. *The calibrating watts of any particular reading = Scale readings ÷ Potential-transformer ratio* (20) × *Current-transformer ratio* (20). Substituting the readings 50,000, 100,000, 150,000 and 200,000 watts and dividing by the product of transformer ratios we obtain:

Switchboard Wattmeter Scale Reading, Kilowatts	Calibrating Watts of Switchboard Wattmeter	Portable Test Wattmeter Readings, Watts
50	125	125
100	250	250
150	375	375
200	500	500

Other readings of the switchboard wattmeter can be checked in like manner.

Excessive Diesel Piston Clearance

It is generally assumed that the piston and cylinder wall clearance of Diesel engines should range from 0.006 to 0.010 in. Before the wear exceeds 0.015 in., or approximately $\frac{1}{64}$ in., it is time to rebore the cylinder and install a new piston or insert a new liner. If the engine is to carry full load with fair economy, 0.010-in. clearance is too great, although it is possible for a Diesel to have a far greater clearance and still carry

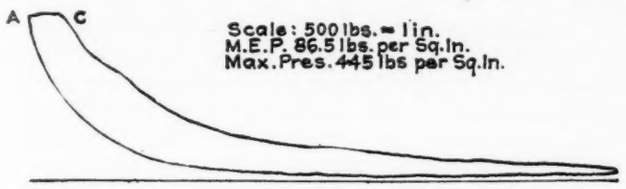


FIG. 1. FULL LOAD WHEN NEW

a fair percentage of its rated load. The fuel consumption, in such event, will show a decided increase.

Fig. 1 is an indicator card from a three-cylinder Diesel taken in 1912 while the engine was carrying full load. The speed was 164 r.p.m. and the injection air pressure averaged 70 atmospheres, or 1,050 lb. gage. The fuel consumption per brake horsepower was computed to be 0.425 lb.

In Fig. 2 is shown a diagram from the engine after five years of operation followed by a two-year period of idleness. At the time this diagram was taken the engine had been re-erected in another locality. It was carrying 120 kw. with the injection pressure at 80 atmospheres and the speed at 145 r.p.m. The drop from the no-load speed of 164 r.p.m. was due to the load being more than the engine could carry while maintaining its speed. In other words, 120 kw. was more than the engine's capacity in its worn condition. On calipering the piston and cylinder, the clearance was found to range from $\frac{1}{8}$ in. to $\frac{3}{8}$ in.

Comparing Figs. 1 and 2, the combustion lines *a-c* are found to be entirely different. In Fig. 1 the fuel was burned at constant pressure, while in Fig. 2 the pressure during combustion, *a* to *c*, apparently follows an isothermal line. The explanation is found in the excessive piston clearance, which allowed the gas to escape almost as rapidly as the combustion took place.

It was at first assumed that the inertia of the indicator piston was responsible for the sharp peak at *a*. However, this point was due to the high injection air employed. The atomizer was of a design that allowed a considerable air charge to blow into the cylinder before the oil charge was picked up by the air current. The pressure in the cylinder at the end of the compression stroke then received quite an increase when the needle valve opened. Fig. 3, which is a distorted card taken from No. 3 cylinder while the indicator rigging was connected to No. 2 piston, shows the decided rise in pressure at the point of fuel-valve opening *a*.

An interestng feature was the ability of the engine to carry a greater load with an increase in the injection air pressure. With 95 atmospheres, or 1,410 lb. gage, the engine was able to carry 150 kw. at 166 r.p.m. Since with 120 kw. and 80 atmospheres, the governor was at its lowest point, the ability to carry 150 kw. with 95 atmospheres was not due to an increase in the fuel charges. In fact, the governor rose to its normal position when the higher injection pressure was used. Fig. 4 is a diagram taken when the engine was operating under these conditions. Employing lower pressures it was found that the engine's capacity followed the pressure changes.

Relief by Raising Injection Pressure

In the operation of this unit the piston clearance was so great that a major part of the cylinder charge of air escaped along the piston as the latter moved outward on the compression stroke. The amount of air contained in the combustion space was insufficient to thoroughly consume the fuel charge without the assistance of the injection air. Since the weight of the injection air entering the cylinder during a given interval of time varies with the air pressure, it is apparent that a higher pressure enables the fuel to be more thoroughly consumed. This is, to all intents, a case of surcharging.

Such procedure is not to be recommended for ordinary operation, but in plants where the equipment is old and the peak load is somewhat greater than the engines can carry, raising the injection pressure to around 80 atmospheres will afford a temporary relief. Care must be exercised to prevent an increase that will cause the fuel valve to wedge open. Adjustment of the needle-valve spring will usually eliminate this danger. It should be understood that very high air pressures will seriously affect the exhaust valves and will impair the cylinder lubrication. This is due to the fact that considerable after-burning, or combustion during expansion, occurs at such times, resulting in high exhaust temperatures.

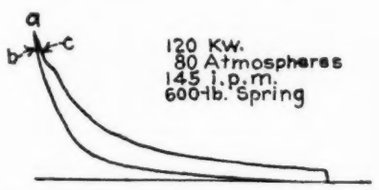


FIG. 2. FULLY LOADED WHEN WORN

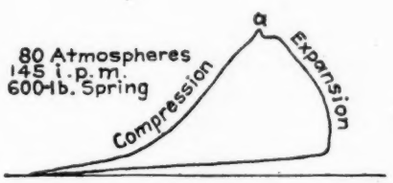


FIG. 3. DISTORTED CARD

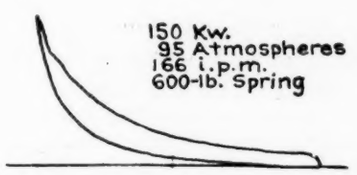


FIG. 4. INCREASED AIR PRESSURE

When the supply of oil to a bearing is interrupted, overheating will prove serious and rapid. The supply of oil may be cut off because a feed pipe has become plugged or through the oil reservoir running dry, broken ring oilers, glazed felt pads or pads which have fallen away from the journal. Dirt entering the bearing with the oil or from outside sources usually results in overheating. The more abrasive materials cause heating because they roughen the journal and bearing, but the softer materials are usually found to have plugged the oil grooves and cut off the oil flow.

Steam-Engine Operation and Maintenance—Lubrication and Oil Pumps

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

WITH wet steam no engine can run satisfactorily for any length of time, as the water will be separated from the steam in the cylinder and carry off the lubricant. A good deal of trouble in this respect is caused through insufficient covering of the steam pipe. It is unreasonable to let steam

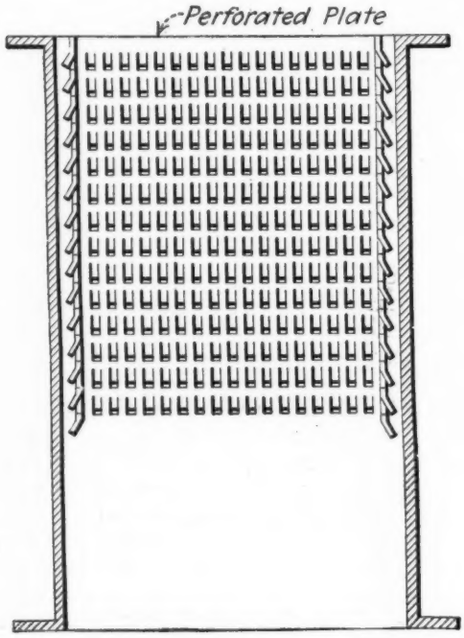


FIG. 1. PERFORATED PLATE IN PROFESSOR SWEET'S SEPARATOR

condense in the pipe and the condensate destroy the lubrication in the cylinder. The fuel required to make the steam condensed in the pipe is a total waste. To cover a steam pipe efficiently is an expense incurred but once, but the loss through condensation in the pipe is continuous and may sum up to a good-sized figure in the course of time. Since about 2½ hp.-hr. are lost per 100 sq.ft. of bare pipe through radiation, which is equivalent to 57 ft. in length of 6-in. pipe, the loss per year would amount to between 15 and 20 tons of coal, the price of which would more than pay for the covering.

Some condensation in the steam pipe is unavoidable, even with the best kind of covering. To keep it from entering the cylinder, it must be separated from the steam. A change in direction combined with a reduction in velocity will effectually separate water from the steam in which it is entrained. A simple contrivance, or steam separator, made of some pipe and fittings, will in many cases answer the purpose. There are, of course, many varieties of steam separators manufactured, for which some wonderful claims are made, but a home-made one like that mentioned above may be just as effective provided the body has ample capacity. One of the most effective separators was originated by Professor Sweet, who as the designer of high-speed engines learned by experience that the best place to separate water from the steam is in the steam pipe near the engine, but not in the cylinder. His separator is practically the same as the one shown in the sketch, except that it has a perforated plate inserted with lips projecting on one side pointing downward, as shown in Fig. 1. The object of the lips is to catch the drops of water and let them drip to the bottom. The so-called receiver separators, which have a large space for the separation and accumulation of water, are far more effective than the smaller kind, which depend on the impinging of the steam on corrugated surfaces. No large accumulation of water in the separator must be permitted, for which purpose the latter should be connected to a trap.

From the primitive tallow cup and the periodical fifteen or thirty minutes' oiling, which were in use and practiced some thirty years ago, engines have graduated into a new class, with oil pumps, self-oilers and highly satisfactory oiling and filtering systems. The joy of the cub engineer to chase round with a long-spouted can and squirt oil into this oil hole or that,

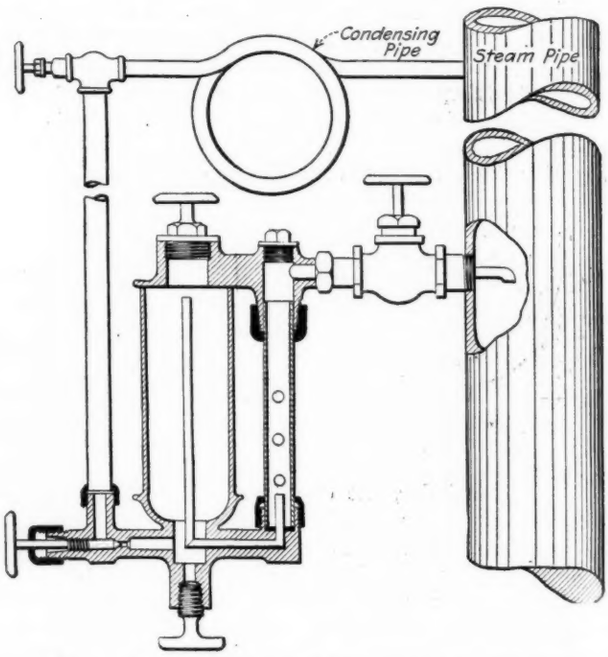


FIG. 2. SECTION OF DISPLACEMENT LUBRICATOR

leaving a trail of oil on the floor or having the spout of his can nipped off in the endeavor to lubricate the link block on a reversing engine, has departed. We see fancy oilstands with beautifully polished copper oil cans exhibited in an engine room, as an ornament, but the cans are hardly ever used.

The first advance in lubrication was the introduction of sight-feed cylinder lubricators, which rest on the

principle of displacing small quantities of oil by condensed steam in an oil reservoir from which it is fed dropwise and visibly into the steam pipe. The operation is made clear in Fig. 2, which shows a general arrangement and sectional view of a sight-feed lubricator. The action of the lubricator is as follows: Steam enters through a small pipe screwed into the steam pipe a few feet above the engine; the steam entering this pipe is condensed and the water led to the bottom of the reservoir underneath the oil, which is raised and discharged through the small vertical pipe and sight feed into the steam pipe right over the throttle. The admission of steam and water and the discharge of oil are controlled by valves; the lubricator can be filled and drained through suitable openings. The sight feed shows the drops of oil on their way to the steam pipe.

All kinds of combinations and variations of designs have been incorporated in these sight-feed lubricators, but the principle is the same in all of them. The oil can be injected at any place in the steam pipe, steam chest or cylinder where it is most desirable, but to become effective for lubrication it must be taken up and thoroughly diffused by the steam. In many cases the oil pipe is simply screwed in and the oil runs down the pipe or wall of the steam chest without lubricating effect. This of course is a waste of the lubricant and will lead to trouble; the oil pipe must enter at least two inches, and its end should point downward to mix the oil freely with the steam.

Displacement lubricators are not positive. There is a possibility of impurities such as scale and sediment being carried along with the steam, clogging the pipes and putting the lubricator out of order. To avoid trouble of this kind, mechanically operated devices in the form of force-feed oil pumps have come into use. They consist of an oil tank in which are immersed one or more plunger pumps driven by eccentrics or racks and pinions, as shown below in Fig. 3. In the eccentric-actuated pumps the plunger moves slowly, the eccentric is driven by means of a ratchet wheel and lever placed on the outside of the tank, the lift of each pump is regulated by stops. A ratchet wheel is likely to become noisy at high speeds.

The other kind of oil pumps, in which the upper part of the plunger is provided with a number of teeth which are engaged by a small pinion, is well adapted for high speeds. There is no lost motion to be taken

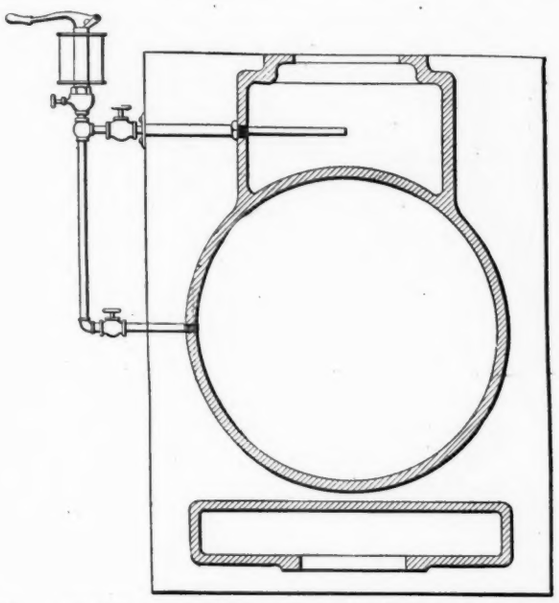


FIG. 5. HAND OIL PUMP ON STEAM-ENGINE CYLINDER

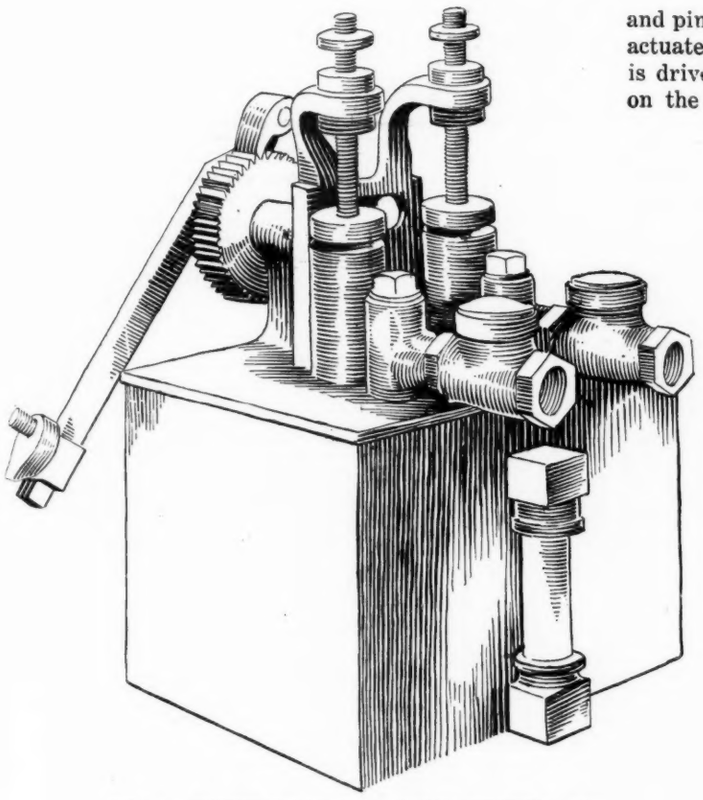


FIG. 3. SIGHT-FEED OIL PUMP DRIVEN BY RATCHET WHEEL

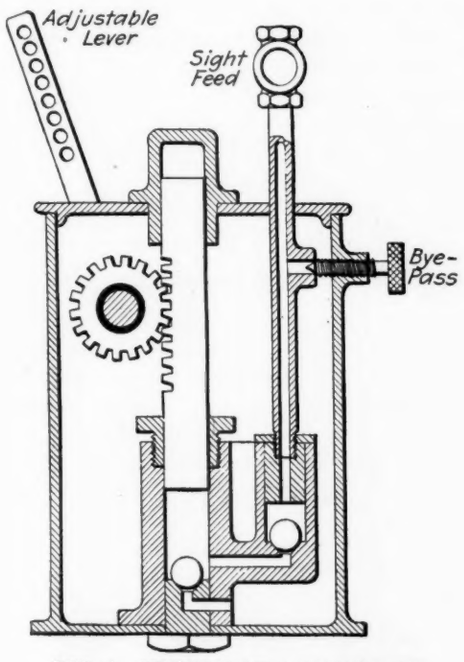


FIG. 4. SECTION OF A SIGHT-FEED OIL PUMP

up, and the plunger makes a double stroke for every revolution of the engine. All the working parts are running in oil; the wear on them is therefore negligible. On this pump the strokes of all the plungers are simultaneously changed by shortening or lengthening the adjustable lever, while the quantity of the oil delivered is regulated by a bypass. The latter is a great convenience for the engineer since it enables him, if necessary, to change the feed to the cylinder and other lubricated parts from a drop to a flood of oil. This feature is lacking in the displacement lubricator, which is therefore as a rule supplemented by a hand oil pump by means of which a considerable quantity of oil can be discharged into the steam chest or cylinder in case of emergency, as shown in Fig. 5. Lubricators or oil pumps for engines up to 100 hp. are generally provided with but one feed, but those for larger engines should have a number of feeds according to the size of the cylinders. On compound engines each cylinder should have a suitable lubricator or sight-feed oil pump.

Rarely is any attempt made to reclaim the cylinder oil carried off by the exhaust; it may be considered as a total loss. To reduce this expense, engineers and managers are tempted to use inferior grades of cylinder oil or reduce the amount used to the lowest possible limit. It is questionable if efforts in this direction can be recommended, since they may result in permanent and costly injury to the engine. There is no sure indication that a cylinder is sufficiently lubricated, except the smoothness with which the piston is working and the appearance of the cylinder bore when the back head is removed; neither can a deficiency in the supply of the lubricant be detected until piston and valves begin to groan and work hard, when on inspection they may be found to be dry and perhaps scored. The idea of cutting down the oil supply by reducing the number of drops per minute until the engine shows distress is certainly wrong, as is also the substitution of a high-priced lubricant by a cheaper article, unless the lubricating qualities of the latter have been demonstrated or its composition found to be of equal merit.

Dragline Cableway Excavator Rehandling Coal

At the plant of the Indianapolis Light and Heat Co. a dragline cableway excavator, designed originally for the handling of sand and gravel, was brought into emergency use to supplement the coal-handling facilities, the recent shortage making it necessary to draw upon storage more heavily than usual. The coal is stored in a concrete pit having a capacity of approximately 30,000 tons. The pit is 100 ft. wide, 300 ft. long and 25 ft. deep. A railroad track running through the center on a level with the top of the pit is supported by a concrete trestle, and the coal is dumped into the pit directly from the hopper-bottomed cars.

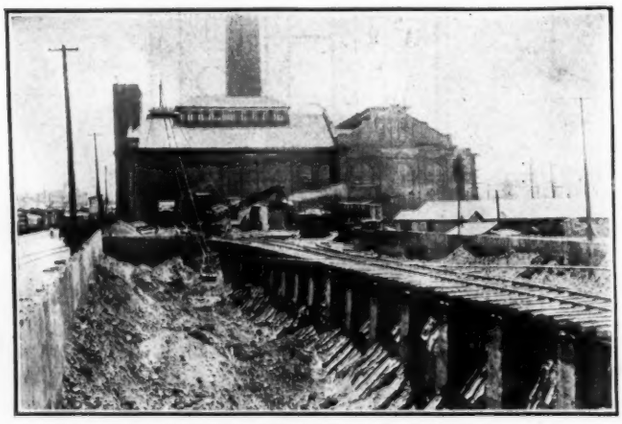


FIG. 1. CABLEWAY AND COAL-STORAGE PIT

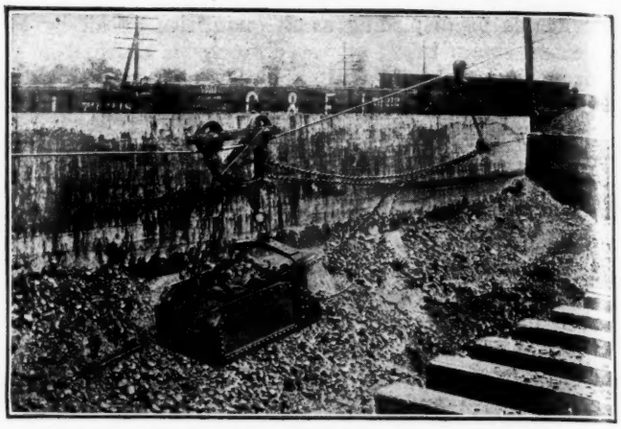


FIG. 2. SHOWING AVERAGE LOAD FOR BUCKET

Ordinarily, the coal in the pit is held as a reserve supply, and under normal conditions the coal for the stokers is unloaded directly from hopper cars to a conveyor system supplying the bunkers. Gondola cars are unloaded by a locomotive crane. When necessary to draw on the reserve supply in the pit, the coal is loaded into railroad cars by the locomotive crane, and again by the same means the coal is unloaded from the cars to the conveyor system supplying the stokers, thereby requiring a double handling of the coal.

During the recent coal shortage the company found it necessary to draw heavily on the reserve, and the locomotive crane was unable to load and unload the coal fast enough to supply the demand. In view of this the company decided to increase the handling capacity by using a ¾-cu.yd. Sauerman dragline cableway excavator which has been employed for cleaning out the intake channel in the creek. The cableway was installed over one side of the coal pit to handle the coal direct from the pit to a hopper on the roof of the power house immediately over the coal bunkers.

An ordinary 8¼ x 10-in. double-drum steam engine is used to operate the cableway. The engine shed is shown behind the locomotive crane in Fig. 1, and the bucket is traveling along on its aërial cable over the pit. A street runs along the outer end of the pit and here the main cable is anchored to upright posts set in the ground along the wall of the pit. By means of a bridle hitch the digging angle is easily changed. The total span of the cableway is 550 ft., and the top of the hopper shown on the roof of the building is 150 ft. above the ground level. In digging from the center of the pit, the operator states he is able to make four trips in nine minutes, handling three-quarters of a ton on each trip.

From the hopper on the roof the coal passes by gravity directly to a crusher and is then delivered to the bunkers supplying the stokers. The floor of the pit is level, and the bucket fills easily and almost within its own length. Fig. 2 shows the bucket loaded.

By means of the augmented supply furnished by the cableway the company has been able to give continuous service.

The Indicator Was Faulty

By G. H. Crawford

After a run of several years, a two-stage air compressor was not giving satisfactory results, so it was decided to take indicator diagrams to locate the trouble. Fig. 1 was obtained from the crank-end low-pressure cylinder. Diagnosis was made that a discharge valve was leaking badly. On examination this was found

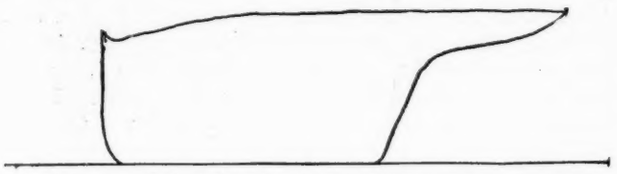


FIG. 1. CRANK END—LOW PRESSURE 80-LB. SPRING

to be the case. One blade from one of the feather valves was missing. The valve was repaired and replaced and the supply of air materially increased.

The investigators then proceeded to take another set of diagrams and were astonished to obtain Fig. 2. The same type was also obtained from the head end of low-

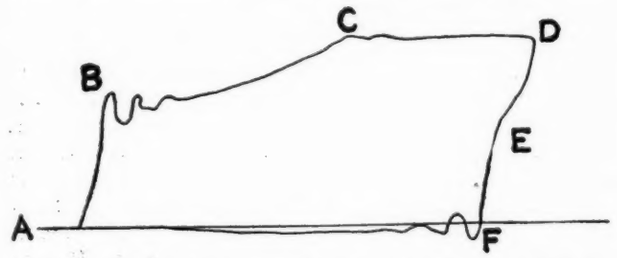


FIG. 2. CRANK END—LOW PRESSURE 80-LB. SPRING

pressure cylinder. Much thinking failed to result in a satisfactory analysis of this diagram. If the curve *AB* had continued its sharp rise to a pressure corresponding to *CD*, it would have been supposed that the discharge valves were leaking badly, which also might have

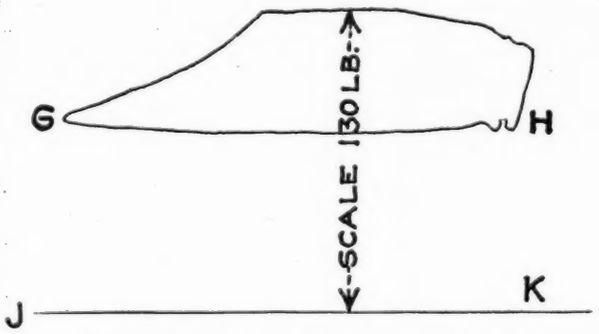


FIG. 3. CRANK END—HIGH PRESSURE 80-LB. SPRING

accounted for the queer re-expansion curve *DEF*; but why the abrupt change at *B*?

It was decided to take a high-pressure diagram, Fig. 3. From inspection this seemed normal.

A leaky piston would have given lean compression curves on both head-end and crank-end cards. Leaky suction valves would also have given lean compression curves and tended to give a square heel to the cards.

Finally, the back head of the low-pressure cylinder was removed and a thorough inspection made. Nothing was found out of order. All the valves were taken apart and cleaned. None of them was found broken. The machine was then re-assembled, and still the same low-pressure diagrams (as Fig. 2) were obtained. The investigators were rather at their wits' end.

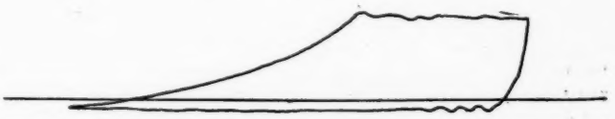


FIG. 4. CRANK END—LOW PRESSURE 60-LB. SPRING

On checking over the indicator it was found that the setscrew that tightens the top ball of the exposed spring was not screwed down tight on the ball, owing to a crossed thread. Consequently, there was lost motion in the indicator piston rod.

On Fig. 2 a line through *BE* would represent the atmospheric line, *AF* being fictitious, due to the lost

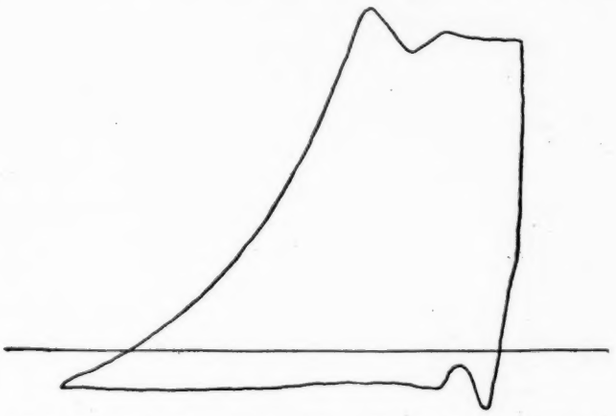


FIG. 5. CRANK END—LOW PRESSURE 16-LB. SPRING WITH UNLOADER

motion in the indicator piston rod. Similarly, line *JK* on Fig. 3 was fictitious, and this should have given the hint as to the trouble. If the high-pressure diagram discharge line had been scaled, it would have shown 130

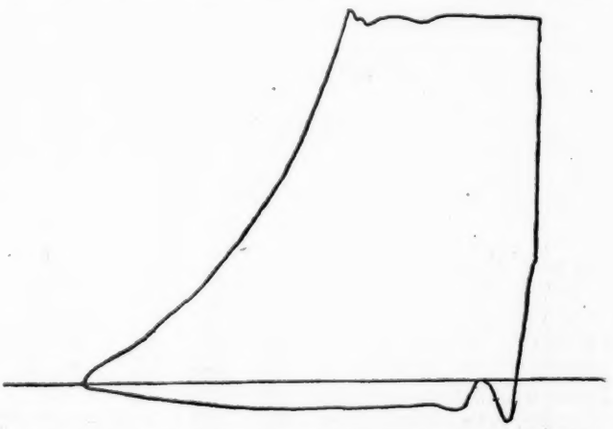


FIG. 6. CRANK END—LOW PRESSURE 16-LB. SPRING WITHOUT UNLOADER

lb. discharge pressure, whereas the high-pressure gage read about 75 lb.

Another indicator was then used and Fig. 4 obtained, which from inspection is good. The reduction of the suction line below atmospheric pressure is due to an unloader with too small lift. Figs. 5 and 6 were taken with a 16-lb. spring with and without the unloader.

Salt-Water Leakage in Condenser

By C. E. Overend

Recently, a very interesting problem was put up to us by a customer. In a system involving a condenser and auxiliaries, including our hotwell pump, the customer claimed, after the unit had run for some time, that we had furnished a pump of inferior metal—in fact, as he expressed it, one made of sand, putty and glue. He supplied a sample of the metal from the water passages of the pump and the sample surely fitted his description, as the pieces submitted looking like burnt molding sand, baked together in cakes about ¼ in thick. The specimens were very brittle, almost crumbling to dust upon handling.

An indirect investigation was started, and upon finding out that the pump was all right when it left the factory, as regards test, inspection and material, an analysis of the specimens submitted was ordered. The chemist reported that the pieces submitted had evidently been treated with some acid or similar liquid and the analysis was as follows: Iron oxide, 65; graphite, 26; silicon, 9.

From the chemist's explanation that the pieces had evidently been eaten with an acid, we realized what had taken place. We asked the customer if he had had any trouble with his unit and he said, "No, none outside of a few leaks in the condenser." Upon being told that the salt water leaked past the tubes into the condensate and thence into the pump and caused the corrosion of the cast iron, he wanted to know why, if this was the case, the cast iron in all the accessories, including the boiler sheet, was not eaten also?

High Velocity Favors Corrosion

He was informed that salt water will attack cast iron at ordinary temperatures and if the water is in violent action, or moving with a high velocity, the part eaten into will be washed away, thus exposing a new surface of metal for the salt water to attack, the action continuing indefinitely. In the condenser itself the water is not traveling at a very high velocity. As a consequence, the salt water at first eats into the iron, forming a thin layer of a mixture which acts as an insulator to the further action of the water. When condenser shells are opened up it is frequently found, especially around the nozzles, that the metal, where exposed to the action of the water, has become quite soft and can be scraped off with a knife. This action, owing to the low velocity of the water, is not carried on to any destructive extent, it seemingly eating in to a certain depth and then it is not carried any further.

In the boilers we have a different condition. Here the high temperatures cause the salt in the water to be thrown down as a scale and precipitate, which is later removed upon blowing out the boiler. Thus the iron in the boilers is not affected by salt in the feed water.

In the case of the hotwell pump we have a fine combination for the destructive action to be carried on. The higher temperature of the condensate, together with the high vacuum and the high velocity of the same through the water passages, helps to make a continuous eating away of the metal possible. The warm solution and the high vacuum cause the fluid to act at an increased rate and the high velocity causes the residue to be carried away thus continuously exposing a new surface of iron for the solution to attack.

It seems to be the consensus of opinion that a very small quantity of salt in water will start a destroying action. One case was cited where the supply water was taken from a well and was supposed to be fresh and free from salt, there not being enough salt in the water to be detected by tasting. The cast iron, however, was attacked, and upon analysis the water was found to contain a small quantity of salt.

Most concerns employing condenser units in their establishments have, at one time or another, experienced this difficulty, and they have found it advantageous to keep a sharp lookout for salt in the condensate. At the slightest detection of salt they immediately open up the condenser, and if only a few tubes are leaking they plug up the ends so that the circulating water cannot enter the leaking tubes and put the condenser back in operation. At some future date, when there are enough condemned tubes to warrant the expense, the condenser is cut out and the leaky tubes replaced with new ones. They find that attending immediately to this trouble saves them enormous repair and replacement bills.

If True, We Are Glad To Know It

(From *Petroleum Magazine*)

Why this twaddle as to the imperialistic designs of Britain on the oil fields of the world? We're all after them. If Downing Street is more active, more keen than Pennsylvania Avenue, it's not the fault of this industry. Conquest by capital is no less complete than that by armed conflict, and if Washington is content to sit idly while London grabs available oil supplies, it's our duty not to yell at the lion but to tweak the eagle.

But in all truth there is no such thing now as British control of the oil business. It is unlikely she ever will dominate it. The petroleum industry is peculiarly that of the people of the United States. This country's production is 82 per cent of that of the world.

We have acquired control of as many acres, if not more, the world over, as has Great Britain. Those who see otherwise are myopic or fanatic. American capital has bought most of the potential fields of South America, than which there is none more pregnant of possibilities. We control three-fourths of the oil output of Mexico, which land yields 16 per cent of the world's production. The fields of Wyoming are likely to fill the gap between supply and demand in this land. The monetary interests of this country also are active in Rumania.

English capital, it is true, eagerly scans the oil lands of Baku and Batum, of Persia and Mesopotamia, but Britain as trustee, under the league of nations, has forbidden development of the latter countries until they shall have re-established themselves. Russ Reds hold the others.

Production of the United States, Mexico and British countries are shown by the following table:

	1918	%	1917	%
World production	514,729,354	....	506,702,902	....
United States	355,927,716	69.15	335,315,601	66.17
Mexico	63,828,327	12.40	55,292,770	10.91
British countries:				
India	8,000,000	1.55	8,078,843	1.59
Trinidad	2,082,068	.40	1,599,455	.32
Egypt	2,079,750	.40	1,008,750	.20
Canada	304,741	.06	205,332	.04
Total	12,466,559	2.41	10,982,380	2.15
Persia	7,200,000	1.40	6,856,063	1.35

Pish, tush—forget the lion's roar and make the eagle scratch a bit.

EDITORIALS

Encouraging Use of Pulverized Rhode Island Coal

AMONG those familiar with its history the mention of Rhode Island coal creates suspicion. Known since 1760, first mined probably in 1768 and many times since mined, it has failed, and failed and failed again. Company after company has tried to exploit it, stock jobbers have come and gone, but the supply of the coal is little more than when British soldiers tried to keep warm with it in Revolutionary days.

Such is the history of Rhode Island coal. Yet, whether or not it is a will-o'-the-wisp, men still chase after it. In fact, one of *Power's* editors was a member of a party that has the last few days been chasing it. But more about that later.

Rhode Island coal is classed as an anthracite. In color it is more of a dark gray than the lustrous black of Pennsylvania anthracite. Its fixed carbon content is very high, samples frequently showing more than ninety per cent and seldom less than fifty-five per cent. The coal is so graphitic that it is mined for this product and the mines are called graphite mines. The ash averages twenty-three per cent and the moisture sixteen per cent. When reading these figures, it must be borne in mind that the character and quality of the coal vary widely. The coal is very heavy; Pennsylvania anthracite has from thirty to forty cubic feet per short ton, whereas much of the Rhode Island coal has a volume of but twenty-five to thirty cubic feet per ton.

So much for the character of the coal.

Other than the vicissitudes of mining, the chief obstacle to the use of the fuel is the difficulty of getting it to burn. Unless a recently tried method of burning it develops into success, it may be said that there has been little success in burning it for commercial steam-making purposes, at least, notwithstanding that the Taunton Copper Company is said to have used it for twenty years. But when pulverized and fed to a furnace in that form, it seems to warrant expectations of a favorable kind.

A party of engineers were invited by the Fuller Engineering Company to witness the combustion of Rhode Island coal under a water-tube boiler equipped with a dutch oven, in the plant of the Allentown Portland Cement Company, Evansville, Pennsylvania. The coal was pulverized, eighty-five per cent passing through a two hundred mesh screen. Though a boiler test was not made, an excellent fire was produced, the color in the furnace being dazzling white, the coal was practically fully ignited within twenty inches from the tip of the vertical burner. Though the temperature of the furnace was high, approximately 2,600 degrees, it was evident that the fuel was capable of producing a temperature much higher than given. As the period over which the fuel was burned was too short, and because no test of long duration made data available, it is not possible to form a worthy conclusion as to the commercial success of burning the coal in this form. But the character of the fire and the ease of controlling it make even the most critical feel optimistic.

Frankly, we are from Missouri. We are indeed optimistic about the commercial success of burning it by the pulverized method, but granting that the method of burning it has been found, can the coal compete with Pennsylvania anthracite and various bituminous coals? The seams in most places lie at steep angles and, we understand, pinch out suddenly from the full thickness of the seam to little or nothing, the seam picking up again and continuing on until pinched out again. The seams, many of them, though many feet in thickness, lie deep in the earth. Can it be successfully mined in sufficient quantities to satisfy prospective users of great quantities of it, and made to pay favorable dividends? Some of those now mining it say it can. The owners and engineers in one of the greatest industrial and coal-consuming areas on earth, under whose very cellars this coal lies, are anxious for the mining companies to prove it.

The Providence Engineering Society is considerably interested and was instrumental in bringing together the parties who recently burned the coal in pulverized form at Evansville, Pennsylvania.

The Integral Economizer

INTEREST in various forms of economizers has been heightened by recent increases in coal prices and by the probability that they will never return to pre-war levels. It used to be said that economizers showed an ultimate saving when coal cost more than five dollars a ton. Even with increased cost of economizers this statement is quite generally true today in large plants.

There are many forms of economizer available—the standard cast-iron economizer, the steel tube economizer and the integral economizer. The last-named form has been tried out in many plants and has certain distinct advantages over other forms. The integral economizer consists of a section built in the boiler setting itself and usually as part of the boiler. It receives the cold boiler feed and heats this water as it passes up the tubes by gases that have already passed over the active boiler surfaces and are on their way to the chimney. Usually, this is arranged for counter-current operation. Such surface is truly economizer surface as distinguished from surface obtained by increasing the tube height of a water-tube boiler, for there is a greater temperature difference between gas and water in the first case. These integral economizers consist generally of an additional boiler element comprising one or more drums and sets of tubes exactly as in the other parts of the boiler itself.

The integral economizer has the advantage of low unit cost compared with standard cast-iron economizers. It takes up small floor space and requires no greater headroom than the boiler itself. Its heating surface is usually made about one-quarter of the boiler heating surface, and as the temperature differences are large

over the whole of this surface, it corresponds relatively to the most effective portion of a standard economizer. Its draft loss is also low as compared with a standard cast-iron economizer.

The principal disadvantage of this economizer is the unknown factor of internal corrosion. When condensate from surface condensers and distilled water are used for boiler feed, there have been cases of severe internal corrosion. In new installations provision is being made to remove the oxygen from the entering feed water and thus prevent this corrosion from taking place. There should be no trouble from external corrosion for the temperature of the leaving gases is sufficiently high to prevent it. This high temperature of leaving gases indicates that the integral economizer, on account of its limited size, does not recover all the heat that a standard economizer might. In many cases, however, the lower investment and relatively greater savings per square foot of surface may warrant the installation of an integral economizer where the full standard economizer is out of the question.

Power Factor Versus Reactive Watts

IN A direct-current circuit a wattmeter not only measures the component of the power that actually does the work but also that which is used to magnetize the circuit. As a result the total volts times amperes supplied to the load is accounted for on the wattmeter. However, in an alternating-current circuit the component of power only that does actual work is registered by the wattmeter. The magnetizing power is first supplied by the generator to the load and then by the load back to the generator; consequently is not recorded on the wattmeter but only circulates around in the system, loading up the equipment without being accounted for in any way. It may be considered as being one instant added to the wattmeter reading and the next instant subtracted from this reading. For a given connected load on the system the magnetizing component is practically constant, where the power component varies as the work done. It is when the magnetizing component becomes equal to or greater than about sixty per cent of the power component that the power factor of the circuit approaches values that are objectionably low.

A polyphase wattmeter may be so connected into a two- or three-phase circuit as to measure this magnetizing component and, when measured, is known as the reactive component or reactive watts. Since the magnetizing watts is the objectionable part of any alternating-current load, and also since this quantity is something that is concrete and can be measured easily, whereas the power factor of an unbalanced polyphase circuit cannot, why not measure the reactive watts and not the power factor?

Knowing the true watts of the circuit and also the reactive watts the power factor or volt-amperes, if either are required, can be determined. Where a cutsomer is to be penalized for low power factor, if this is applied in the form of a charge for reactive watts it will be for something that he can read from his own meter and not a value that is figured in about as many ways as there are penalty clauses. What the reactive watts are can be explained much more easily than power factor, and the problem of metering is greatly simplified. The most serious objection that can be raised against measuring the reactive watts with a wattmeter is that when harmonics are present in the circuit there will be an error in the reading, but this is so small in most commercial circuits as to be of little consequence. However, a high degree of accuracy in measuring either power factor or reactive watts is not as essential as in measuring the watts. Past experience has shown that if these values can be determined within a few per cent they will be satisfactory for all practical purposes.

The fact that power factor is a term used since the introduction of alternating current is no reason why it should continue to be used. Like many other things it may have served its usefulness and may have to give way to some other factor that will more adequately meet the present development in the electrical industry. The factor that most readily meets all the needs is reactive watts, and this has the support of many eminent electrical engineers.

There are three kinds of boiler efficiency: First, the standard of performance which good design, conscientious firing and the best of maintenance would make possible; second, that efficiency which the operator thinks he is getting, and third, the actual facts, namely, the true operating performance as judged by the pounds of steam per pound of total coal consumption. All too often the second of these—the operator's belief—is based on the makers' statement of what the plant should do. This is no time for continuing upon either of these bases. What is needed is to get down to facts and see where we stand.

Attorney General Palmer and C. S. Allen, Secretary of the Coal Trade Association, New York, issued a joint statement July 27 in which the view was expressed that appointment by the Attorney General of a committee to decide on a fair margin of profit for producers and dealers in bituminous coal, beyond which prosecutions under the Lever Act will follow, is expected to "have a deterrent effect upon those who are now taking excessive profits." How many of them will be in jail two months from now?

The first convention of the National Board of Boiler and Pressure Vessel Inspectors will be held shortly. No state, city or other political division should fail to send the man who is legally responsible for the enforcement of its boiler laws. He will bring back the experience of others in administering the law and in searching out defects, which may mean the saving of many times his expenses, and he will become part of a national organization to prevent a class of accidents the preventable number of which has been a national disgrace for many years.

There was, it is likely, justification for some of the suspicion with which cold storage was regarded some years ago, and for the legislation restricting that industry. But the world war seems to have wiped the slate clean and to have left the industry unshackeled. Cold storage was of vital importance in winning the war. It is capable of as much in time of peace. The right kind of legislation will do as much good for the industry as for the public.

CORRESPONDENCE

Carelessness in Refrigerating Plants

Coming intimately in contact with a number of refrigerating engineers in various parts of the country, I can truthfully say that most of them are careful men, but I have found some of these same engineers making mistakes, sometimes with disastrous results—not from carelessness, but rather from thoughtlessness.

As an example, assume that Jones has read an article the previous evening on heat transfer or some other interesting engineering subject; he might perform his daily duties in the engine room to perfection, but at the same time might also be going over in his mind the different points he read of the evening before. He goes about his various duties, such as starting up the compressors, pumps, adjusting expansion valves, etc., through force of habit. What to do and what not to do comes to him without serious thought on his part, owing to his having done the same things many times before. Here is where some trouble might creep in when a person is doing one thing and thinking about another.

To illustrate this point, I remember an instance last winter in a plant I was visiting. The engineer had pumped all the ammonia out of a cold storage house to do some repair work and regasketing of the coils, and had stored the ammonia in the condenser and liquid receiver. The temperature outside was about 8 deg. F., and in the engine room it was about 75 deg. The receiver full of liquid became an evaporator and naturally frosted all over and caused considerable dripping of water on the floor. This was objectionable, and to remedy this he shut off the liquid and gas relief valves between receiver and condenser. We all know what the result should be with a liquid receiver, without a safety valve on it, full of 8 deg. below zero ammonia in a 75-deg. engine room, but fortunately this did not happen. The gage glass burst instead. The engineer knew what the trouble was instantly and, realizing what he had done, hastened to open the valves on the receiver. Nothing further happened.

This was a plain case of thoughtlessness. A careless man, as a rule, is a lazy man and would not have taken the trouble to climb a ladder to the top of the receiver to close the valves, as this engineer did. The receiver in question was an old one, made of extra-heavy 16-in. pipe, 18 ft. long. It stood upright in a corner of the engine room and was not equipped with a safety valve. It is easy to imagine what damage to life and property would have been done if this receiver had burst. It probably would have killed or injured the entire refrigerating crew.

Another case of thoughtlessness: The valve stem on the main suction line, an angle stop valve, began to leak, and the engineer climbed up on the steam line to tighten it with a 24-in. wrench. The valve was five feet above the steam line and near the engine-room wall. On this wall was a receptacle and lamp to light the upper part of the engine room. The engineer placed the wrench on the stuffing-box nut of the valve, braced himself as well as he could, leaned out and gave the wrench a hard jerk. The nut was not so tight as he thought it was and the handle of the wrench when it came down broke the electric light globe and the engineer received a shock of 220 volts, tumbled off the steam line, and on his way down grasped the one-inch liquid ammonia line from receiver to expansion valve, and of course it broke, letting the whole charge of ammonia go into the engine room.

The engineer barely escaped with his life, suffering a sprained ankle and several bruised ribs, caused by hitting the engine-room floor.

The following incident should be classed as carelessness:

The oiler in an engine room was scrubbing the engine-room floor with a 1¼-in. hose. As he was in a hurry he had plenty of pressure on the hose so he could quickly wash down. Alongside the flywheel was a piece of 12 x 12-in. pine block, about two feet long, used as a fulcrum when jacking the engine off center. In playing the hose around the pillow block he struck the block square in the center with the high-pressure stream and it tumbled into the moving flywheel. There was a roar and a bang and the engine room was full of steam.

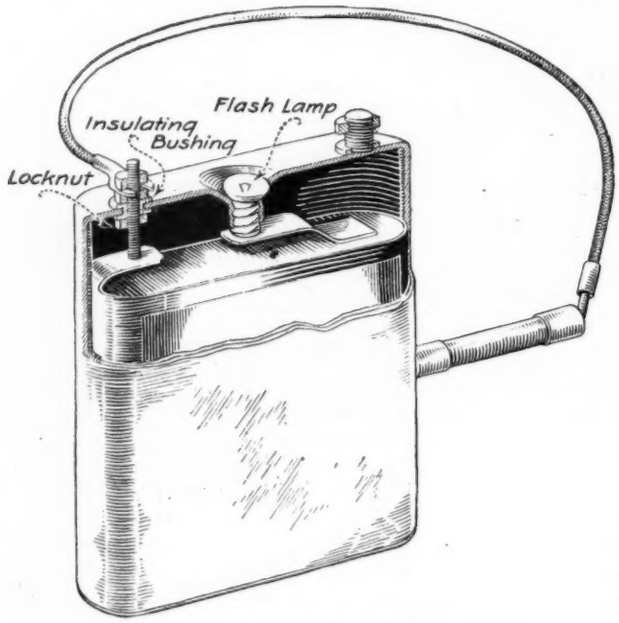
The oiler beat a hasty retreat out into the street. The enginer was up in one of the cold storage rooms, but the fireman had presence of mind enough to shut off the steam line on the boiler header. I happened to come into the engine room about the time the escaping steam had stopped, and we were able to see what was wrong. The block of wood which was washed into the flyheel made a revolution or two with the wheel, then was forced out and up at an angle so that it struck the valve wheel on the main steam line to the engine, which was on a line with the edge of the flywheel, breaking the valve stem and stuffing box off the bonnet of the valve just inside of the bolts holding the bonnet to the body of the valve.

This piece of carelessness caused a shutdown of about six hours until a piece of boiler plate could be drilled and fitted into place of the bonnet, as a temporary repair.

Chicago, Ill. C. E. ANDERSON.

A Testing Device That Can Be Carried in the Vest Pocket

Numerous equipments for fuse testing have appeared from time to time in *Power* and no doubt have proved their value to those who designed them. Most of these devices derive their power direct from the plant current supply through a lamp or bank of lamps and are



BATTERY FLASHLIGHT TESTING DEVICE

a fixed or stationary part of the plant equipment, which decreases their value to a considerable extent. I have designed, and used to advantage, a testing device that can be carried in the vest pocket. This outfit may be used to test fuses, open-circuits, short-circuits or grounds—in fact, for locating almost any trouble found in the everyday work of the electrical department of an industrial plant.

As indicated in the figure, the fuse-testing apparatus is made up from an ordinary pocket flashlight. To the top of the flashlight case, after taking out the flash switch, I soldered a terminal, as shown to the right. On the opposite side I drilled a hole and inserted another terminal. The left-hand terminal is insulated from the case and held in place by two nuts. This terminal comes in contact with the flashlight-battery terminal.

In the figure the equipment is shown used to test a cartridge fuse. By bringing a lead out from the right-hand terminal, tests can be made with the battery case in the pocket.

Chadwick, N. Y. JOHN GRANT.

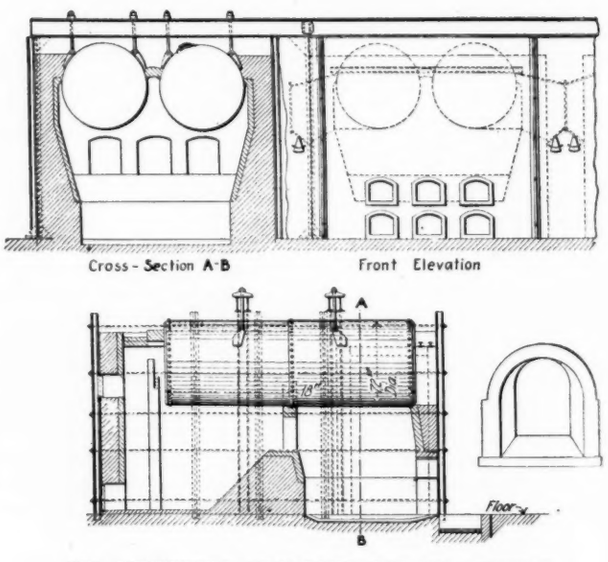
Proposed Setting of Return-Tubular Boilers

In the July 6 issue of *Power*, page 28, is a contribution by M. Riewerts, "Proposed Setting for Return-Tabular Boilers," in which he suggests a change from the present installation of 38 in. from the grates to the boiler shell to 60 in. and gives a sketch of the proposed settings of two units, etc. Neither the natural draft of the plant nor the boiler efficiency nor the evaporation is mentioned, and it is not stated whether forced- or natural-draft furnaces or stokers have been or are to be used after the change in the setting has been made.

If forced draft is used, the higher setting will be necessary to protect the boiler shell, and particularly the belt-line seam, from the blow-pipe effect produced by forced draft. If natural draft is used, there will be no appreciable advantage in the higher installation, because in either case the gases will stratify, the hydrogen rising to the top along the sides of the boilers and passing rearward. The heavier, air-mixed strata will pass rearward under conditions that do not produce the much desired results of approximately perfect combustion of furnace gases, unless a great excess of air above that necessary to produce combustion is admitted to the furnace.

A wall such as shown by the cross section *AB*, provided with ports or openings, was installed under some boilers in Chicago about twenty-five years ago, but they were short-lived and inefficient and were soon discontinued, as was also the inverted arch back of the bridge wall. I have frequently removed the wall *AB* for cause, and also the inverted arch found in many boiler settings during my ten years' experience in Chicago.

Experience has demonstrated that the wall *AB*, if needed at all, is not correctly located, as it does not protect the boiler shell or the belt-line seam. It does not render efficient aid in eliminating smoke or in assisting in the proper combustion of the furnace gases. There is too much talk about burning smoke. If the mixture of air and gas is correctly controlled, in proper proportion, in front of the bridge wall and when



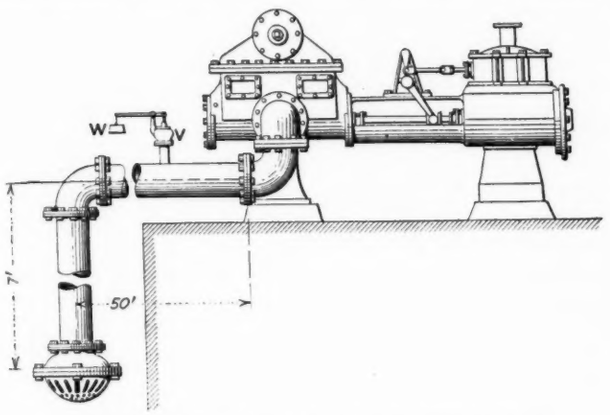
MR. RIEWERTS' PROPOSED BOILER SETTING

passing rearward to the combustion chamber, the combustion of hydrogen will be completed, the use of large volumes of surplus air will be avoided, the smoke problem will be solved and economy of fuel will result. These conditions can be successfully and economically produced when the boiler is located but 36 in. above the grate, and no greater space is required.

Buffalo, N. Y. THOMAS E. MARTIN.

Water Hammer in Elevator Pressure Lines

The Royal Poinciana Hotel at Palm Beach, Fla., is the largest wooden structure in the world, and the elevators are located at the heavy traffic points, some of them as much as fifteen hundred feet from the pumps. The report I got when I went there was that the hydraulic lines were always noisy and during the rush before the Washington's Birthday ball an almost continuous water hammer was the rule. The repair man on the elevators said that he used to take the pumps apart a number of times each season, thinking that the pistons were loose.



POSITION OF AIR VALVE ON SUCTION LINE

The pressure is furnished by 20 and 14 x 18-in. duplex pumps with a 12-in. suction and a 10-in. discharge pipe. When I started up last fall, we first put a service elevator to work and it went along fine, but as the help began to come in by the trainload, we had to start up several other service cars, and then the noise began and could be heard all over the lower floors of the building. The pumps acted as if the pistons were loose, and as the main line ran under my office, I gave the matter a lot of thought.

On the suction of one of the pumps was an old arrangement for putting compressed air into the system. It was not in use and was shut off at the discharge line. A leak developed in this old air pipe and that night the pump lost its suction and would not pick up the water again with the discharge pressure on the upper valve deck. The operator shut it down and put on another pump. In the morning I tried the pump against no pressure and found the leak when water squirted out of the rusted pipe. As it was on the suction line, I could not account for the pressure unless the valves on the discharge leaked. It was only 1-in. pipe so I disconnected it at the discharge and plugged it both ways. Upon starting the pump again, water squirted out, keeping in step with the pump reversals. Then it dawned on me what was the matter with the elevator system.

The suction tank was 50 ft. from the pumps, and when a number of cars started at once and lowered the pressure, the pumps would start and pull away from the water, as it takes time to start a body of water flowing; and when it did catch up to the piston, there was a knock, and this jar was passed through the piston to the moving water on the discharge side.

An air chamber on each suction pipe, with the run of water directed into the air chambers and a supply of air kept in the chambers, would be the proper thing in this case. This is how we arranged it. I found an old 1-in. outlet valve that had been removed from an ice-plant skim tank. It had a float that would open the valve when the water reached a certain height. We removed the float and put on a five-pound weight *W*, and then connected the valve in the suction lines as shown. The operation is as follows:

When the pump starts and the piston pulls away from the water, it creates a vacuum stronger than necessary for the low lift; then the atmospheric pressure overcomes the weight and opens the valve *V*, and air rushes into the suction pipe; this air acts as a cushion and stops all noise. The weight *W* will keep the valve closed during the time that the pump is running steadily, as it is proportioned so that the vacuum required to keep the capacity rate flowing through the suction pipe to the pump will not open it.

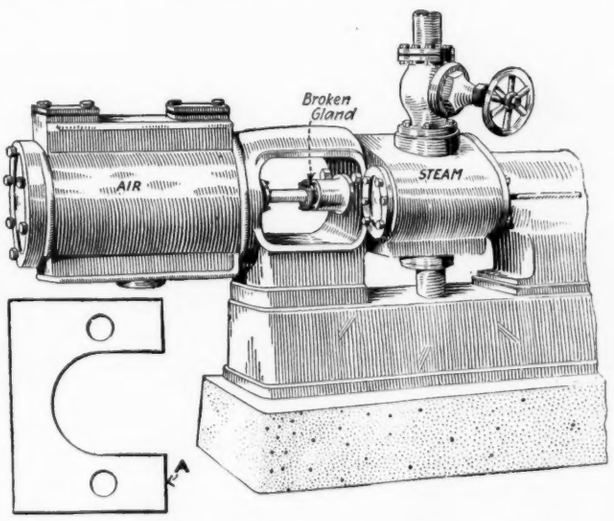
On the other pumps we put even a more simple air-cushion arrangement. We punched six holes in the suction pipes with a prick punch and tapped them ¾-in. iron pipe size. Then we took ¾-in angle valves and filed off the threads on the stems so that they were free to move up and down. We had to break off the handles leaving the hub on the stem so as to make the stem of the right weight to lift at excessive vacuum and stay closed at ordinary running. The pumps ran quietly throughout the season, starting and stopping with the demand, and the air pulled in kept the proper cushion in the pressure tanks that were situated at the elevator groups.

The same principle was applied to a house pump that was quite noisy during the rush between 9 and 11 a.m.

Palm Beach, Fla. JOHN H. RYAN.

Reinforcing a Broken Stuffing Box Gland

The sketch shows the steam and air cylinders of an air compressor, the stuffing-box gland of which broke about eight months ago, on the steam end, as indicated.



BROKEN GLAND AND REINFORCING PLATE

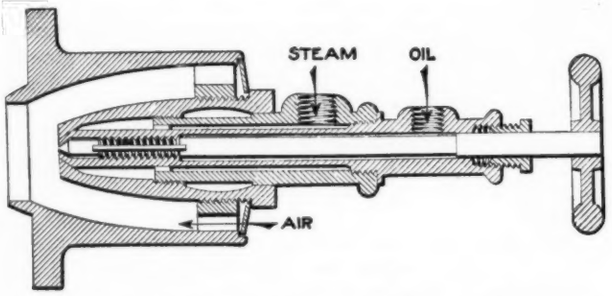
An emergency repair job consisted of placing a piece of iron plate *A* over the broken gland. Of course longer studs had to be made, but the makeshift worked all right in keeping the gland in place. W. F. JOHNSON.

Howes Cave, N. J.

Early Use of Fuel Oil

Over forty years ago, in the City of Detroit, D. H. Burrell & Co., of Little Falls, N. Y., installed a third factory for cutting hoops. It was reported to the home office that the factory was losing one hundred dollars per day. The fuel used under the boilers was elm bark and refuse from the hoop making. I was sent out there, and on the way I decided to use crude oil for fuel. This was done by sprinkling the wet shavings from the elm hoops with crude oil and shoveling the shavings into the furnace as usual. By this method steam was kept up and the mill was kept running to capacity, turning the loss to a profit.

Our success in burning oil brought us trouble, however, in the shape of protests from insurance men on account of its fire risk, so we began making a pipe and tank system, also a good burner. The factory taxed Captain Tard to keep it supplied with logs, and in after years it cut up all the available timber. The heat from



SECTIONAL VIEW THROUGH BURRELL LIQUID FUEL BURNER

the burners quickly made ash of the bark and refuse, which paid the running expenses and kept the yard clean. The ashes from the furnace were sold to soap makers at a clear profit.

I reported our success to officials of the Standard Oil Co. at Cleveland, and they offered to assist in procuring the best and cheapest oil. At my request the barrels for the Detroit mill were branded "Fuel Oil," which was proposed as a trade mark. I advertised the oil in trade papers and by means of circulars, and this publicity gave an impetus to liquid fuel because of the success of fuel oil over coal or wood in meeting the conditions at our plant.

The burner that was adopted is shown in the illustration and was known as the Burrell Liquid Fuel Burner with Naylor Improvements. Mr. Burrell, who was interested in various enterprises and did much in the development of this burner, died about a year ago. The main features of the burner were that, owing to its heating and super-heating chambers, it readily decomposed the steam and thoroughly vaporized the oil, and the regulation of the steam and oil vapor was within the nozzle; the admission of air could be regulated to the requirement of the oil and steam, so as to give an intense flame. There is in the Little Falls office of the company one of these old burners, and I believe the original patents are still preserved.

In 1862 I had a model working power plant consisting of a steam boiler piped to a turbine, the steam being generated by a common naphtha burner. Liquid fuel was successfullly used, but that is another story.

Arlington, N. J. JAMES NAYLOR.

Unsteady Engine Speed

I have a friend who had a pain in his left knee cured by having an infected tooth pulled, but I had no idea that such a wide separation between cause and effect could take place in the realm of mechanics, and in my own plant at that. A few days ago I thought I could detect a slight wave effect in the noises and hum of my 15 x 18-in., 200 r.p.m. engine, that is equipped with an inertia governor and is directly connected to a 150-kw. a.c. generator. After a little study I concluded that the governor was hunting slightly. By noon the hunting was a little more pronounced, and I took a look over the governor to see if the gag element was at fault, but it was all right. I then became a little puzzled, for this was a new behavior for a governor that had had a most perfect record for over eight years. During the afternoon run the wave effect increased and I observed that the ammeter hand was swinging slightly and in step with the engine noises. Another search that night revealed everything as being all right, but the next day the hunting increased until it amounted to 30 amperes on the switchboard and could be detected all over the yard in the engine exhaust.

I was greatly puzzled and decided to take down the governor arm that night, having visions of a broken roller or some such thing about the suspension pin. Then I happened to stumble into the trouble. This unit drives 21 induction motors ranging from 5- to 40-hp. capacity. In the afternoon I was called to the mill to change the leads and reverse one of these motors.

Traced to Loose Fan Belt

Close by the one I was working on was a 40-hp. motor driving a large fan, and as I worked I noticed that the hum of this motor had a decided swinging rise and fall, apparently in step with the hunting of the engine governor. I next noticed that the long belt connecting this motor with the fan was flapping its upper or slack side up and down, instead of running in waves as slack belts often do. This flapping of the belt, rise and fall in the hum of the motor and the hunting of the governor were all evidently in step. I took this to be the effect of the governor's hunting.

Then the thought occurred to me that perhaps the order was the other way about, and that it might be possible that this belt was alternately grabbing and letting go on the pulley as it flopped and that this was communicated back to the engine in the nature of a surge because the motor load would be on and off in impulses, as if a clutch were being thrown in and out.

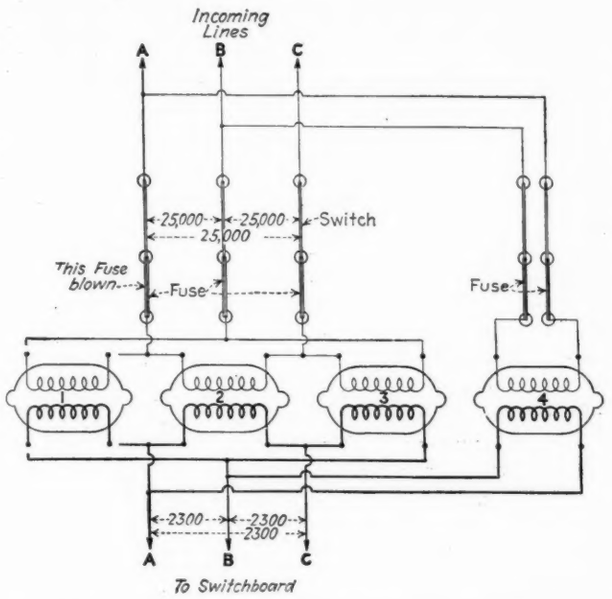
I grabbed a bar of belt dressing and touched it to the belt. Presto! The flopping stopped and the motor hummed in a beautiful even note. I almost ran to the power house and behold, all was serene once more and apparently no hunting.

I moved the motor back on its base sufficiently to tighten the belt, and now my supposed governor trouble has disappeared. The cause of the trouble was due to a new belt that had been put on the fan motor, and its gradual stretching accounted for the slow and steady development of the hunting effect on the governor. Some unusual coincidence between time, weight and force in the belt on the motor and the inertia bar and weights in the governor must have been struck, so that, being in step with each other, the belt was able to keep a sensitive governor swinging. R. MANLY ORR.

Vancouver, B. C., Canada.

Blown Fuse Caused Voltage To Be Unbalanced

In an electrical pumping station the transformers are arranged as shown in the figure. The current used is transmitted at 25,000 volts three-phase and is transformed at the station to 2,300 volts by means of a bank of four single-phase transformers. The scheme of operation calls for three transformers to be in service at one time, being connected in closed delta, with the fourth one as a spare unit. This spare unit is interchanged with the other three at stated intervals. At the time referred to transformers Nos. 2, 3 and 4 were in service, with No. 1 cut out. All units were protected by high-potential fuses as shown.



SCHEMATIC DIAGRAM OF TRANSFORMER CONNECTIONS

A severe electrical storm caused the switch at the main power house to trip, and at the same time the fuse was blown, as shown in the figure. This, however, was not known until later. After service was restored, I tried all three phases for voltage, and as they balanced, I started up the motor-driven pump. Just before reaching full speed, a matter of two or three seconds, the automatic circuit breaker on the motor circuit tripped. Investigation showed the cause of the trouble to be a blown fuse. I tested each phase for voltage again and found that they exactly balanced. However, when the fuse was restored, starting conditions became normal.

Ordinarily, a blow fuse on a three-phase circuit is indicated by an unbalancing of the phases, but, in this particular scheme of connections the blowing of the fuse was not known until I attempted to start up. The unbalanced condition of the phases caused the motor to draw excessive current, which tripped the circuit breaker. The fact that the circuit breaker was controlled by a time-limit relay accounted for the motor nearly reaching full speed before the breaker opened.

Pittsburgh, Pa. M. A. ANDERSON.

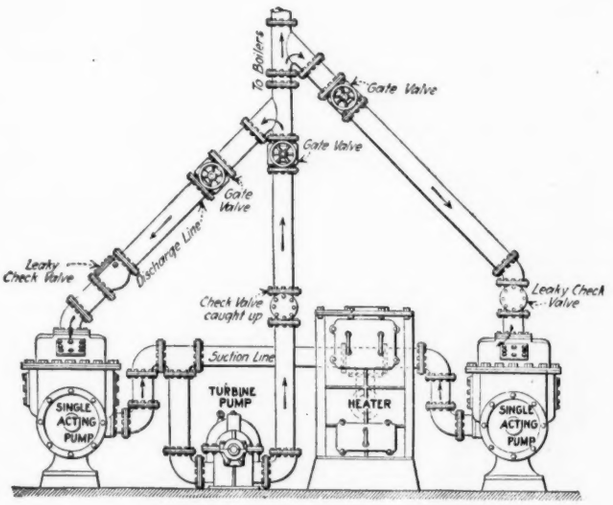
[With the fuse blown as shown in the figure, transformer No. 2 was cut out of circuit, leaving Nos. 3 and 4 connected opened delta, which, either under balanced-load or no-load conditions, should give practically a balanced voltage. However, the two transformers will have only 58 per cent of the normal capacity of three units, consequently when the motor was started a very heavy overload was thrown on the two transformers. This accounts for the circuit breaker opening when the motor was started, rather than an unbalancing of the voltage.—Editor.]

Leaky Valves Cause Shutdown

A large power plant in this vicinity was obliged to shut down for a short time, owing to leaky pump and check valves in the boiler-feed pumps and discharge lines. The plant has nine water-tube boilers of 6,000 boiler-horsepower, supplied with water by three pumps, two of which are single-acting and the third a turbine. The turbine will supply the boilers when they are worked at the highest rating, but it requires the two single-acting pumps to supply them when the turbine is down. The three pumps are connected to one suction line from an open heater; the discharge lines are connected to the feed line by two laterals close together.

At the time of the trouble the turbine pump was feeding the boilers and the load was about normal. When the load was changed, with a consequent demand for more steam, the low-water alarms on three of the boilers began to blow. The water tender opened the bypass valves on these boilers, which reduced the supply from the other boilers, causing the water in them to go low. The engineer ordered the fires drawn and shut the plant down. The two single-acting pumps were then started, steam raised again, and the engines started. They had run about fifteen minutes when the low-water alarms began to blow again. Then the plant was shut down a second time for low water.

It was found that the two check valves on the discharge lines of the single-acting pumps were leaking and the turbine was pumping the water back to itself, and that when the single-acting pumps were working, the check valve on the turbine was caught up, letting the water go back to the suction line. After closing the gate valves on the discharge lines from the single-acting pumps, the turbine was started and supplied the boilers without trouble.



PIPING AND LOCATION OF VALVES

C. J. MILLER.

North Tonawanda, N. Y.

Power Failure Caused Accident

Some time ago I witnessed a curious incident; although no one was injured, it resulted in a heavy repair bill. A large pumping station was being operated on central-station energy by means of a transmission line several miles long. The pumping station was located at the foot of a steep hill, and the centrifugal pumps discharged into a 36-in. line which went directly over the hill at an altitude of 250 ft. At the time of the accident but one pump was in operation, it being driven by an induction motor having a wound rotor; the normal speed was under 900 r.p.m.

An incident at the power house was the cause of the switch controlling the power to the pumping station being opened, which of course suddenly cut off the power to the pump. The sudden stoppage of the motor and pump caused a high-pressure surge in the pipe line, on the suction side of the pump, of sufficient force to cause a rupture of the pipe line a few hundred yards from the pumping station. Instantly, the centrifugal pump was transformed into a turbine operating with a wide-open valve, neither load nor governor to control the speed, and a head of 250 ft.; a very high speed was the immediate result.

As soon as the pipe line emptied itself (a matter of a few seconds), the pump and motor stopped. An investigation showed that the coil ends of the wound rotor had lifted (owing to centrifugal force developed by the enormous speed) and had cut into all the stator coils, resulting in a new winding being necessary.

When the rotor was rewound, extra-strong bands were placed on the coil ends and a check valve was placed in the pipe line to prevent a repetition of such an occurrence. There was no way of telling how fast the unit rotated, but the engineer on duty estimated the speed at 3,000 r.p.m. Of course the direction of rotation while running as a turbine was the opposite of that while operating as a pump. Pieces of the winding were thrown out with sufficient force to penetrate a ⅜-in. wire-inserted window glass.

Pittsburgh, Pa. M. A. ANDERSON.

Boiler Inspection Reveals Careless Operation

Some time ago I was called upon to inspect some boilers at a sawmill plant, and on my way from the railroad station to the mill I was informed that one of the boilers had exploded the previous morning. Naturally, I had visions of boilers scattered all over the mill yard, for there were five in all, and they had the reputation of being questionable characters.

Arriving at the plant, I was met by the superintendent and was told that the boilers were ready for inspection and that the manhole frame of No. 4 boiler was broken. I surmised at once that this was the explosion referred to by my informant. Proceeding to inspect the boilers, I began with the one having the broken manhole frame. This reinforcement was made of cast steel and was single-riveted to the shell. I found it split in three places through the rivet holes.

Looking over the top of the boilers and wondering what could have caused the manhole frame to break and why the sheet did not rupture at the same time if the boiler had been operating under normal conditions and pressure, I saw that the safety valve was missing and that a three-inch plug was screwed in its place. From the attendants it was learned that several weeks previously the safety valve had been taken off and sent away for repairs. Having no extra valve, they simply stopped up the opening with the plug, and no thought was given to the possible danger of operating the boiler without a safety valve.

About this time I began using a little plain language to show these men what a chance they were taking through such carelessness. During the conversation I was able to get a few facts about the manipulation of the plant that showed both carelessness and incompetency.

It appeared to be customary, after shutting down at night, to cut out three boilers, and the remaining two were fired, to supply steam for the dry kiln. It was the night attendants' duty to raise the steam pressure on the idle boilers and cut them in ready for service in the morning.

Through neglect, and probably quite often, the night attendants found themselves with hardly enough time left in which to raise the steam pressure on the idle boilers and get them cut in for service ready for the day crew. Then the seemingly impossible was accomplished by opening the main steam valves on the idle boilers, allowing the pressure from the other boilers to rush in and finally become equalized, the attendants thus evading a much-deserved reprimand.

After getting this information, together with the fact that the boiler with the broken reinforcement was one of those cut out each night, it did not take long to surmise that a water-hammer had broken the manhole frame. The attendant being at the main stop valve at the time was able to shut off the higher pressure immediately, thus no more damage was done.

At another time I was summoned to inspect three boilers in a plant that had just changed hands. Two of the boilers were return-tubulars, the third being a dry-back Scotch marine.

Getting into the combustion chamber of the last-named boiler, I noticed that the ashes were quite wet. In looking about to ascertain where this moisture came from, I found that the arch overhead protecting that part of the back head above the water line from the flames had practically all fallen away. Upon closer examination of this part of the head numerous little cracks were found extending out from the rivets attaching the braces to the head, which had been caused by overheating.

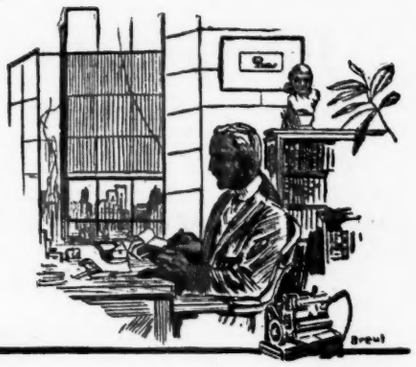
I recommended that the brace rivets be cut out and the head be straightened (for it was slightly bulged in between the brace rivets) and that a reinforcing plate be applied to the affected area on the outside of the head and fastened by patch bolts, the brace rivets to extend through the reinforcing plate, thus making a neat and substantial job.

Now, as all conscientious and careful engineers know, one of the first things to do in taking charge of a strange plant is to find out, as far as possible and as soon as possible, the condition of all apparatus under their care, for a little attention at the proper time may prevent painful accidents and expensive repair bills.

In conclusion I might say that such cases as related are quite numerous, and almost without exception would not have happened if a little more care had been exercised by both the management and the operatives.

Chattanooga, Tenn. P. E. TERROY.

INQUIRIES OF GENERAL INTEREST



Cement for Faced Steam Joints—How is a good cement made for faced steam joints? W. L. D.

Take equal parts of powdered graphite, red lead and white lead and mix them thoroughly with boiled linseed oil to the consistency of a thick paste.

Higher Economy for Greater Speed of Engine—What effect has relative speed in the economy of a reciprocating steam engine? B. M.

For the same initial pressure and point of cutoff, the weight of steam used per indicated horsepower per hour is somewhat reduced as the speed of rotation is increased, probably due to the reduced loss by cylinder condensation at higher speeds.

Advantage of Using Steam With Reduction of Pressure—What is the advantage of generating steam at high pressure for supplying an engine with the steam reduced in pressure by passing it through a pressure reducing valve? F. N. G.

The initial pressure on the engine may be kept more nearly constant and generation of steam at the higher pressure is equivalent to increasing the volume of the steam space of the boiler. Wire drawing of the steam, by reducing the pressure, is a means of converting the steam to a dryer condition at the lower pressure. But unless the steam supplied by the boiler is perfectly dry, or very nearly so, there can be no superheating.

Setting Valve from One Dead Center—How can a plain D slide valve be set without turning over the engine? R. M. G.

First set the valve to give the same maximum port opening on the two ends of the cylinder. For this purpose, loosen the eccentric on the shaft and turn it around until it gives the maximum port opening on first one end of the valve and then on the other. If the maximum port openings are not equal, they are to be made so by changing the length of the valve stem by one-half of the difference in the maximum port openings. The engine is now to be put on a dead center and the eccentric is to be turned on the shaft and set to such a position as to give the valve the proper lead. This adjusts the angle of advance of the eccentric and will give equal leads at the two ends of the cylinder.

Starting and Stopping Boiler Test—For making an evaporative test of a boiler, how are identical conditions of firing and water level obtained for starting and stopping the test? C. T.

For a hand fired test, the fires should be cleaned immediately preceding the test and the final clean out so timed as to be completed just before the end of the run. With mechanical stokers the conditions under which the test is to be run should be established at least 30 minutes before starting the test, and the same conditions should be established at least 30 minutes prior to the close of the test. The water level marked on the gage glass at the beginning should be the same at the end of the test, in each instance with closed fire and ash pit doors, to obviate discrepancies of water surface from circulation of the boiler due to a difference of cooling effect of air admitted.

Dry Saturated and Superheated Steam—What is the difference between dry saturated steam and superheated steam? W. L. G.

Steam is said to be saturated when it is at the evaporation temperature corresponding with its pressure. When steam is formed in a boiler and rises from the surface of the water it is saturated and remains saturated as long as it is in contact with the water. Its condition is said to be "dry saturated" when the steam contains no particles of unevaporated water. Steam is said to be superheated when its temperature is higher than the temperature of evaporation corresponding with the pressure. Superheating must be performed by adding heat to the steam after it has been removed from contact with the water in the boiler and providing for increase of its volume without a corresponding increase of pressure; or saturated steam may be converted to a superheated condition at a lower pressure by wiredrawing, when the heat contained per pound of the steam at the higher pressure is more than the amount of heat required for the condition of dry saturated steam at the lower pressure.

Decreasing Voltage and Frequency on Induction Motors.—The statement has been made that if the voltage and frequency are reduced on an induction motor, as by reducing the speed of the alternator supplying the power, the magnetizing current remains constant. If this was absolutely correct, when the voltage and frequency reached zero the magnetizing current would still be of normal value, which is impossible. Where is the error in the foregoing statement? A. E. M.

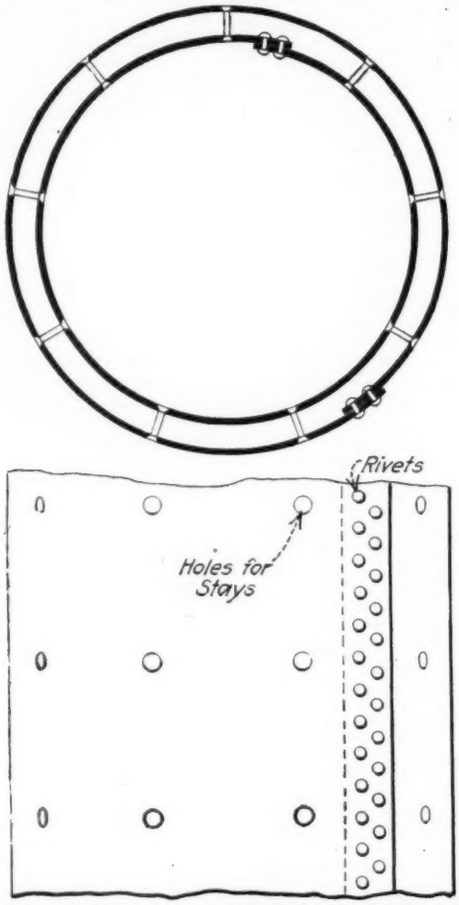
At no-load in an induction motor, operating on normal voltage and frequency, the magnetizing current is practically equal to the voltage divided by the impedance of the motor circuit. This impedance is made up of two right-angle components: one, the ohmic resistance of the stator winding and the other the inductive reactance of the winding. At normal voltage and frequency, the inductive reactance is so high compared to the ohmic resistance that the latter can be for all practical purpose neglected. Therefore if the voltage and frequency are reduced, within reasonable limits, say 10 per cent, the inductive reactance are reduced in a like proportion, and since the ohmic resistance is practically negligible, the magnetizing current will remain nearly constant. However, when the voltage and frequency are reduced by say 90 per cent of normal, then the inductive reactance is also small, approaching the value of or less than the ohmic resistance of the winding, consequently the latter has a very marked effect upon the magnetizing current, causing it to decrease as the voltage and frequency decrease. It is therefore evident that the statement in the question is not absolutely true. When the reduction in voltage and frequency from normal is only a few per cent, the decrease in the magnetizing current is very small and may be neglected but, as the lower limits are approached, the magnetizing current begins to decrease rapidly.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. —Editor.]

Interpretations of the A. S.M. E. Boiler Code

The following answers to requests for interpretations of the Boiler Code have been prepared by the Boiler Code Committee and approved by the Council of the American Society of Mechanical Engineers. The formal inquiry and reply are given together with explanatory references to the code and illustrations where necessary for a better understanding of the interpretations as issued.

Case No. 299—Inquiry: In using Par. 212 to determine the maximum allowable internal working pressure that may be allowed on a staybolted surface under the Code Rules it is stated that the weakening effect produced by drilling the staybolt holes must be considered. Cylindrical surfaces



CASE 299. EXAMPLE OF CYLINDRICAL SURFACE WITH STAYBOLT HOLES

of the character referred to in this paragraph usually contain a riveted joint that weakens the structure more than does the drilling of staybolt holes. Should not the weakening effect of such joints be considered in the applying of Par. 212?

Par. 212 provides that the maximum allowable working pressure shall be computed as in the case of a cylindrical shell, making allowance for the weakening effect of the holes for staybolts. To this may be added the smaller of the pressures secured by the formula for stayed surfaces (using 70 for the value of C in the formula) or the pressure corresponding to the strength of the stays. In the illustration the code requires the strength of the outer cylindrical shell to be figured only with allowance for the weakening effect of the staybolt holes, making no provision for a case where the riveted joint shown has a lower strength than that of the plate between the staybolt holes.

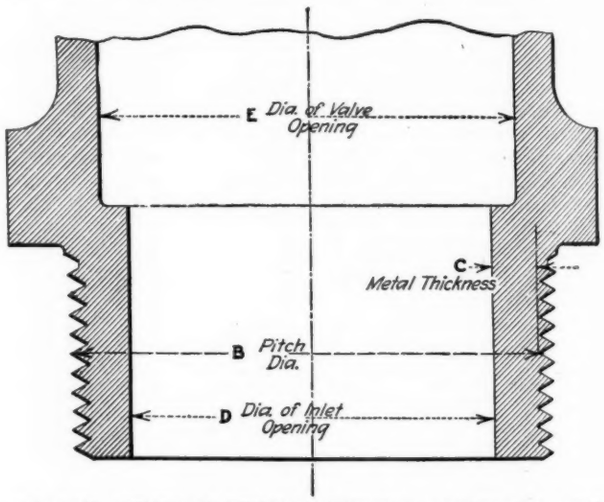
Reply: It is the opinion of the committee that where the curved staybolted surface referred to in Par. 212 contains a riveted longitudinal joint, or other construction except handholes, and the strength of the surface through such joint or other construction is less than through any line of staybolt holes in the same direction, the weakening effect of the joint or other construction, instead of that produced by the drilling of staybolt holes, is to be considered in making the calculations for pressure by this paragraph.

Case No. 301—Inquiry: Is it the intent of the Boiler Code under Par. 182 that the back pitch of tubes and rivets in drums which have a relatively high ratio of shell thickness to diameter of drum shall be measured on the inside surface, the outside surface, or the median line of the shell?

Par. 182 defines the back pitch as the distance between any two adjacent rows of rivets measured at right angles to the direction of the joint. The minimum back pitch if $\frac{P}{D}$ is 4 or less shall be $2D$. If $\frac{P}{D}$ is over 4, the back pitch shall be $2D + 0.1 (P - 4D)$ where P is the pitch in the outer row when a rivet in the inner row comes midway between two rivets in the outer row; and the pitch in the outer row minus that in the inner row where two rivets in the inner row come between two in the outer row, and D is the diameter of the rivet holes.

Reply: It is the opinion of the committee that in measuring the back pitch of tube holes or rivets the measurements should be made on the flat plate before rolling, so that in checking up these measurements after construction the result would correspond to the dimensions on the median line, or the mean of the measurements on the outside and inside surfaces.

Case No. 302—Inquiry: Is it the intent of Par. 278 of the Boiler Code, which requires a full-sized direct connection to the boiler for each safety valve, that the exact meaning of this term shall be applied to small brass pop safety valves with male inlet connections? It is impossible to maintain the nominal threads on the inlet of these valves if the inlet opening is maintained full-sized in a male connection.



CASE 302. SECTION OF MALE THREAD CONNECTION FOR SMALL SAFETY VALVE

Reply: It is the opinion of the committee that the rule given in Par. 278 of the code applies to the connection leading to the safety valve and not to the safety valve itself. There need not be a full-sized opening through the valve itself, as the stamping of the capacity thereon by the manufacturer indicates in any case what is actually guaranteed for the valve by the maker.

Under the requirements of Par. 278 the rating of a safety valve is limited to the size of the opening at D in the illustration. It is desirable that the threads on the small male-threaded connections should conform to the nominal pipe threads for the rated size. If such thread size is used and the opening at D is made the full diameter of the valve, there appears to be a question as to whether there will be enough metal under the threads.

Assuming, for example, a 2-in. valve, the diameter at the bottom of the Briggs standard thread is given as 2.201 in., and if the opening at D is made the full 2 in. diameter the thickness of metal under the thread will be 0.10 in. The area of the metal cross-section, then, would be 0.628 sq.in., and with 250 lb. per sq.in. pressure under the 2-in. valve disc the stress in the connection would be 1,250 lb. per sq.in. This would seem to be a reasonable working stress for good brass castings, and some manufacturers so consider it. The standard internal diameter for extra-strong wrought-iron pipe is 1.93 in. Using this dimension

for the diameter at *D* gives a metal cross-section of 0.85 sq.in. and a stress of 924 lb. per sq.in. One manufacturer's standard for such valves calls for a diameter at entrance of 1.77 in., which results in a metal area of 1.35 sq.in. and a stress of only 655 lb. per sq.in.

From the consideration of area at inlet to the valve, the full 2 in. diameter would give 3.14 sq.in., the 1.93 in. diameter, 2.93 sq.in., and the 1.77 in. diameter 2.46 sq.in. The area through the seat for a 2-in. valve with a 45-deg. seat is 0.44 sq.in. for a 0.10-in. lift and 0.89 sq.in. for a lift of one-tenth of the valve diameter. It would thus appear that with as small an entrance diameter as 1.77 in. the valve might safely be rated at 2 in. This would avoid the akwardness of bastard size ratings and at the same time avoid any question as to the strength of the construction.

Case No. 303—Inquiry: Is it the intent of the Boiler Code Committee in its references to commercial lap-welded pipe in Case No. 218 that the weld therein may be considered as conforming to the requirements for welded joints in Par. 186 of the Boiler Code?

Case No. 218 refers to the use of open-hearth, extra-heavy lap-welded steel pipes as headers and manifolds of superheaters. The reply in this case holds that such parts must be made from material which, in its initial form of plate or skelp, conforms to one or the other of the specifications for wrought steel, or they may be made of cast steel of Class B grade.

Par. 186 provides 28,500 lb. per sq.in. as the ultimate strength of a joint welded by forging with steel plates having a range in tensile strength of from 45,000 to 55,000 lb. per sq.in.

Reply: For calculations of the maximum allowable working pressures to be permitted in open-hearth lap-welded pipe used in connection with boilers, it is the opinion of the committee that the weld may be assumed as meeting the requirements of Par. 186.

Case No. 304—Inquiry: What amount of cooling and shrinking under pressure is necessary in the driving of rivets under the requirements of Par. 256 of the Boiler Code? Is it consistent with the intent of this paragraph to release the pressure while the rivet shows any degree of heat redness in color?

Par. 256 requires that rivets shall be machine driven wherever possible, with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure.

Reply: It is the opinion of the committee that the pressure should be maintained upon the rivet after it is driven until no part of the head shows red in daylight.

Case No. 306—Inquiry: Is it the intent of Par. 20 that the minimum thicknesses of tube sheets there specified for horizontal return-tubular boilers is applicable also to vertical fire-tube boilers and to locomotive-type boilers?

Par. 20. The minimum thickness of tube sheets for horizontal return-tubular boilers shall be as follows: When the diameter of the tube sheet is 42 in. or under, $\frac{9}{16}$ in.; over 42 in. to 54 in., $\frac{7}{16}$ in.; over 54 in. to 72 in., $\frac{1}{2}$ in.; and over 72 in. $\frac{9}{16}$ in.

Reply: It is the opinion of the committee that while this paragraph refers specifically to horizontal return-tubular boilers, it is equally applicable to boilers of the vertical fire-tube and of the locomotive types, and its application to these two latter types is recommended by the committee.

Tensile Properties of Boiler Plate at Elevated Temperatures*

At the request of a committee of the Engineering Division, National Research Council, a study of the properties of boiler plate at various temperatures up to about 900 deg. F. has been instigated. This paper is a report of preliminary tests made on $\frac{1}{2}$-in. open-hearth boiler plate of marine and firebox grades.

Special apparatus was designed to carry the extension measuring apparatus so that the indicating devices might be outside a tubular electric heater which surrounded the specimen while under test. The measured length of the specimen was 2 in., and its temperature was measured by a thermocouple inserted in a small hole drilled in the fillet.

The curves in Fig. 1 show the results of tests on firebox-grade steel at temperatures from 70 deg. F. to 870 deg. F., and those in Fig. 2 show the results from marine-grade steel under similar conditions. The curves are the average of three determinations at each of the pick-points. The values for reduction of area were obtained from measurement of the minimum width and thickness of the fractured section and are not identical with values that would be obtained by the use of a planimeter, owing to a decided necking in both width and thickness in rectangular specimens.

The increase in temperature results in distinct changes in the properties, namely: (a) The tensile strength first decreases, reaching a minimum at about 200 deg. F., then increases to a maximum at about 550 deg. F., after which

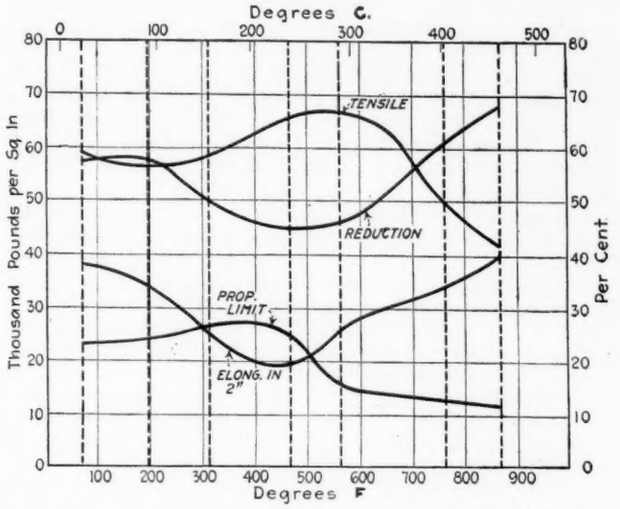


FIG. 1. RESULTS OF TESTS OF FIREBOX-GRADE BOILER PLATE AT VARIOUS TEMPERATURES

a final decrease occurs; (b) the percentage elongation in 2 in. decreases slowly to about 200 deg. F., then rapidly to a minimum at 470 deg. F., after which it increases; (c) the reduction in area closely follows the curve for elongation, but has its minimum at slightly higher temperature; (d) the proportional limit increases slightly to a maximum at about 400 deg. F. for firebox steel and between 200 and

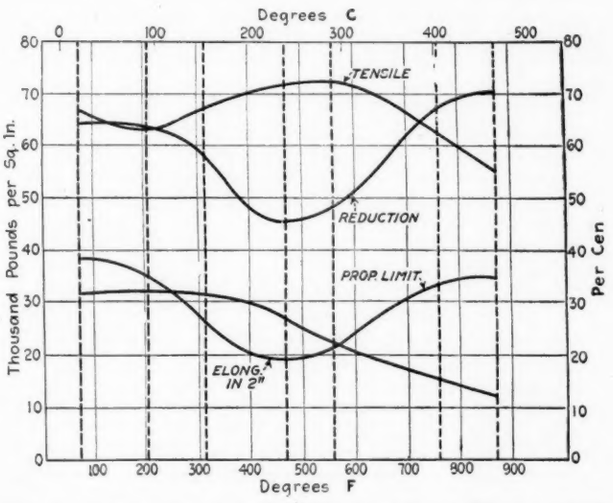


FIG. 2. RESULTS OF TESTS OF MARINE BOILER PLATE AT VARIOUS TEMPERATURES

300 deg. F. for marine steel. It is noted that for firebox steel the increase is greater and the decrease takes place more sharply than for marine-grade plate. The higher temperature for the maximum value of the proportional limit with firebox steel is credited to the greater mechanical work received by these samples.

Fifteen coal operators and brokers were recently arrested at Knoxville, Tenn., on charges of profiteering, and will be prosecuted under the Lever Act. Between fifty and sixty more, it was learned, are to be arrested charged with the same offense.

*Abstract of a paper by H. J. French, Chief, Heat-Treatment Section, Division Metallurgy, United States Bureau of Standards, presented before the American Institute of Mining and Metallurgical Engineers.

Operation of a Diesel Motor Ship

The following record of the Motor ship "Selene," covering a period of one year, which appeared in *The Engineer*, London, should be of interest.

The "Selene" has the following dimensions: Dead-weight capacity, 5,310 tons; gross tonnage, 3,738 tons; length, 357 ft. 6 in.; breadth, 46 ft. 3 in.; depth, 27 ft. 7 in.; draft (forward), 21 ft. 4 in.; draft (aft), 24 ft. 0 in.; propelling power, 2,200 i.hp.

The "Selene" left Singapore on Oct. 5, 1918, for coasting ports. In these ports no particular work was executed, but, as usual, when a vessel is loading or discharging cargo various work had to be done, such as cleaning filters, cooling pump examined, and air compressor valves to be cleaned, etc.

This ship arrived back in Singapore on Nov. 9, and then made a voyage to Australia, experiencing no trouble and arriving on Dec. 29. Work carried out during the ship's stay in port consisted of examining and grinding in air compressor valves and overhauling cooling water pumps.

During the voyage from Adelaide to Balik Papan the starboard motor was stopped for ¾ hour for renewing a joint on the exhaust-valve box.

The vessel arrived at Balik Papan without any further trouble, and while the ship was in port the exhaust valves of the starboard motor were taken adrift and ground in, and also some small repairs were carried out.

Voyage Balik Papan to Singapore—When at Singapore the following work was executed: Fuel rollers seen and adjusted, some telescopic piping and stop valves seen to, and all bolts on main motors tried.

Voyage Singapore to Bordeaux—Work in latter port consisted of cleaning fuel filters, interchanging air-compressor valves, inspecting lubrication, I.P., H.P., and air-compressor pistons opened up, the rings renewed, and all grooves trued up.

All crosshead, crank bearings, and main shaft bearings fitted, and fuel valve needles repacked.

Voyage Bordeaux to Abadan—The ship left the latter port on April 17, when the port motor was stopped for 1¾ hours for air compressor; and on April 19 the starboard motor was stopped for two hours for interchanging an exhaust valve.

The vessel arrived in Port Said on April 29 and reported "all well," and then proceeded to Abadan, where she arrived May 18 without having experienced any trouble.

On arrival at Abadan the suction and delivery valves, air compressors, main and auxiliary motors were opened up and cleaned.

Fuel and lubricating oil filters were also cleaned and two exhaust valves changed.

The "Selene" then left for Colombo and then round to the coast ports, eventually arriving at Singapore for her periodical docking on June 26. During this overhaul the following incidents were noticed:

All bearings and crankpins opened up for inspection of the crankshafts, and after careful inspection were found to be in good condition.

The starboard shaft was worn down 0.7 mm. over all bearings, and the usual wearing toward the middle bearings was not noticeable in this case.

The port shaft was worn down 1 mm. in the No. 1 bearing, 0.8 mm. to the middle bearing, and 0.6 mm. in the No. 8 bearing. All journals were bearing very nicely, and no sign of salt-water being mixed with the lubricating-oil was noticeable.

All bearings and crankpin brasses were adjusted.

Two pistons were taken out for examination and found in good condition; as the other pistons were not leaking, they were left untouched.

Further to this, the usual repairs were done when vessel was in dry dock. The ship left dock on July 13 for two coast voyages and turned back to Singapore on July 19 without experiencing any trouble.

Work executed during stay in port was: Repacked some fuel-valve needles, renewed two piston bolts, and secured cooling water pump straps, etc.

Vessel left port for Suez on July 23.

On July 25 both motors were stopped for ¾ hour for examination of crankshaft, and on Aug. 1 both motors were stopped successively for ½ hour to examine bottom-ends, and also on Aug. 10 the starboard motor was again stopped for 3 hours for broken slipper guide bolt.

Without any further difficulties vessel arrived at Suez on Aug. 18. During ship's stay in port discharge of cargo the following work was done: L.P. and I.P. air-compressor rings renewed, valves and air-compressors cleaned and ground in, fuel filters and mud boxes cleaned, etc.

Vessel passed through the Suez Canal and left Port Said for Hull on Aug. 27.

The port motor was stopped on Sept. 2 for ½ hour for fastening up piston bolts on No. 5 cylinder, and also on Sept. 12 for 2 hours for renewing two broken-off piston bolts.

The vessel arrived without further accidents at Hull on Sept. 12, when practically no repairs were found necessary.

Having given this information *The Engineer* makes the following comments:

It would be possible to gather quite a disconcerting impression from this report by laying stress upon the fact that in a series of trips covering some 50,700 nautical miles eight stoppages are recorded, and it is necessary to analyze these carefully before coming to any conclusion. The causes of the stoppages are given as follows:

			Engine
(1)	¾ hr.	To renew joint on exhaust valve box	Starboard
(2)	1¾ hr.	For air compressor	Port
(3)	2 hr.	To exchange exhaust valve	Starboard
(4)	½ hr.	To examine crank shaft	Both
(5)	30 min.	To examine bottom ends	Starboard
	20 min.	To examine bottom ends	Port
(6)	3 hr.	For broken slipper guide bolt	Starboard
(7)	½ hr.	To tighten piston bolts	Port
(83)	2 hr.	To renew two broken piston bolts	Port

We much regret, says *The Engineer*, that we have to admit that we have not been able to obtain such full explanatory notes on all these stoppages as to appraise them justly, and a good deal must be left to surmise. We can say, however, that Nos. 1, 3 and 6 need not have caused stoppage of the engine at all if it had been thought necessary to keep it running, as the particular cylinder affected could have been cut off without interfering with the working of the other five. In No. 6 the slipper-guide bolt was connected with the water service and on that account would have necessitated either the stopping of the engine or the cutting out of the cylinder. Nos. 2, 7, and 8 were perhaps the most disabling casualties and probably called for the immediate stoppage of one engine, whereas it is important to note that only one engine had to be stopped at a time, and all the other stoppages were of such a nature that not only could the trouble be rectified in a short time, but the engineer could to a very large extent choose his own time for the stop to suit the bridge. It is only the stop which puts the ship completely out of control and which occurs without notice to or consultation with the bridge that causes real anxiety.

Cold-Storage Insulation Efficiency

While many factors, such as resistance to moisture, inflammability, strength, durability, etc., must be considered in choosing an insulating material, the material must of necessity be a good insulator and the measurement of its thermal conductivity is, therefore, the matter of most importance. The Bureau of Standards has used for several years a satisfactory apparatus for measuring thermal conductivity. The results obtained have been assembled and a standardized form of apparatus suitable for general use has been designed. The American Society of Refrigerating Engineers has taken an active interest in this work, so that a standard apparatus may be available, the use of which will eliminate disputes due to differences resulting from the employment of unsuitable testing methods.

The results of the bureau's work will be published in a forthcoming number of the *Journal* of the American Society of Refrigerating Engineers, will be issued as a Bureau of Standards scientific paper, and abstracted in *Power*.

"Aquitania" Now an Oil Burner

After having been off the transatlantic route for eight months, the Cunard steamship "Aquitania" sailed from Liverpool, July 17, for New York. The liner has been completely refitted and converted into an oil burner and on her return voyage established a new speed record.

The "Aquitania" had just completed three round voyages between England and America when the war broke out. Rapidly converted into an armed merchant cruiser, carrying six-inch guns, she left the Mersey on Aug. 8, 1914, for patrol duties. Later on in the war she served as a hospital ship, and then again in the spring of 1918 she was employed as a transport, rushing American troops to Europe.

The 168 furnaces of the 21 boilers of the "Aquitania" have been changed from coal burning to oil burning. In a ship like the "Aquitania," assuming that the 28 fires are cleaned every watch, approximately 8,000 hp. is lost every four hours, due to the drop in steam pressure during the cleaning period.

With oil-fired boilers there is no such loss incurred, as the oil can be supplied continuously to the burners, and the furnace temperature maintained so that a constant steam pressure can be kept up, which will improve the speed of the vessel.

As the temperature of the boilers is maintained at a constant figure, the bill for boiler repairs will be considerably reduced. There will be no ashes to remove, and consequently no dust and inconvenience to passengers from that source.

Location of Fuel Tanks

In this ship, with a beam of 97 ft., with three large double-ended boilers arranged abreast, there remains a space of about 18 ft., amidships, gradually reducing to 6 ft. at the forward end of the boiler space, which formed the coal bunker on each side, and in this space, extending the full length of the boiler space, a matter of 369 ft., the oil is carried. These side tanks do not form one continuous group on each side, but are broken into two groups, port and starboard, by Frahm's anti-rolling tanks, which take up 32 ft. of the length. In addition to these side bunkers, large athwartship bunkers, arranged forward of No. 1 boiler room, between Nos. 1 and 2, and between Nos. 2 and 3, have also been made suitable for oil carrying. The large storage capacity in these side tanks and cross-bunker tanks, however, did not prove sufficient to enable the ship to perform the double trip without requiring replenishing, so that six of the double-bottom tanks have been made suitable for oil, to enable the 7,600 tons of oil required to be shipped at New York. Of the total quantity, 5,200 tons will be carried in the fore and aft side bunkers, 1,900 tons in the athwartship gross bunkers, and 700 tons in the double-bottom tanks. All the storage tanks, including the six double-bottom tanks, will be used solely for oil, no water ballast connections being provided.

To make the coal bunkers suitable for carrying oil, a large amount of structural steel work was necessary. For instance, all the bunker bulkheads have been specially stiffened, so that deformation will not occur with the weight of oil pressing against them.

All the plate joints have been specially treated, the general practice adopted being to fit stout double-riveted joggled plate straps over each plate landing, making a thoroughly oil-tight joint. Special attention has been given to plating and riveting of all steam-pipe trunks and passages where these penetrate the cross bunkers.

Transverse wash bulkheads have been fitted in all the side bunkers, and suitable wash bulkheads have also been constructed in the cross-bunker tanks to insure that oil is not in any way affected by the movement of the ship.

For the full length of the side bunkers and also around the cross bunkers, gutterways have been constructed to catch any oil that may find its way outside the tanks through leaky joints. In communication with these gutterways are bilge wells in each boiler room from which the oil bilge-well pumps draw.

In the cross-bunker storage tanks forward of boiler rooms Nos. 1, 2 and 3, four settling tanks have been constructed, each being of 60 tons capacity. In No. 4 boiler room two settling tanks of similar capacity each have been incorporated in the side bunkers, one port and one starboard.

In this ship there are four boiler rooms, the three forward ones each containing six double-ended boilers, and the after one three double-ended boilers. Two settling tanks are provided for each group of three boilers.

In certain parts of the boiler rooms the side bunkers overhang the wing boilers, and to insure that there will be no chance of oil dripping on the hot boiler tops, special screen plates have been fitted in the way of these overhanging parts, so that any oil that may leak through will be directed to the oil gutter below.

Electric Welding Employed

In addition to the special riveting that has been adopted to insure oil-tight joints on all the tanks, electric welding has also been largely employed, with the result that a thoroughly sound and substantial tank construction has been made. The oil fuel is burned under the "White" low-pressure mechanical system, which has proved efficient and reliable on existing oil-burning vessels.

The pumping and heating plant consists of a complete installation in duplicate for each group of three boilers; that is, in the large boiler rooms each containing six boilers there are four sets of pumping and heating plants, while in the small boiler rooms there are two sets. This insures that only under very exceptional circumstances will the supply of fuel to the burners be interfered with through any fault of the pumping plant.

For the full length of the boiler rooms two 8-in. suction and filling mains are provided, one port and one starboard. In each boiler room these mains are cross-connected, and in addition suitable shutoff valves are provided, so that the system in one boiler room can be isolated from any other boiler room.

Special attention has also been given to the bunkering arrangements, so as to insure that the minimum of time will be required to bunker the vessel. Each boiler room is provided with two 8-in. filling pipes from the working deck, one port and one starboard. These pipes communicate with the suction mains.

Special filling compartments have been arranged on "E" deck, where the connections for coupling to the tank steamer or shore hose are fitted. These compartments are separate from adjoining accommodation, so that should any oil escape from the save-all trays which are fitted under the valves and strainers, the oil will not be free to spread over the deck.

On each side of the ship there are four connections for bunkering purposes. Should the connections on one side of the ship be in use at one time, it would be possible to bunker the vessel in about six hours.

No Possibilities of Overfilling

Special precautions have been taken to eliminate all possibility of overfilling the tanks. A special arrangement of air and overflow pipes has been installed, by means of which, should any tank be inadvertently overfilled, the oil will overflow into one of the storage tanks specially arranged for this purpose. An overflow storage tank is provided in each group of tanks in each boiler room, port and starboard.

With the arrangement of overflow pipes and tanks, a sequence of tank-filling must be adhered to. These overflow connections, however, are fitted only as a safeguard should the other means provided for ascertaining the quantity of oil in the tanks fail.

Each storage tank is provided with a Pneumercator gage. By means of these gages the depth of oil and the quantity in the tanks can be noted at any time. It is usual to fill the tanks to 95 per cent of their capacity, and this quantity is indicated on each Pneumercator gage. In addition to these gages, electric float alarms are fitted, so that when the 95 per cent capacity level is reached a bell rings. No sounding pipes are fitted in any of the oil tanks

To insure that the oil will run freely from the tanks in cold weather, or when heavy oil is being used, heating coils are fitted in all the side-bunker tanks and in the double-bottom tanks, but not in the cross-bunker tanks, where it is considered the heating of the adjacent boiler rooms renders heating coils unnecessary.

From the storage tanks the oil is pumped by large vertical direct-acting pumps to the settling tanks. Two of these transfer pumps are fitted in each boiler room, those in No. 4 room being of 70 tons per hour capacity each, and those in the other boiler rooms of 100 tons per hour capacity each. The capacity of each settling tank is such as to insure sixteen hours' supply for three double-ended boilers, so that about fifteen hours will be allowed for the settling of the oil in one tank while the other tank is in use. To facilitate separation of water from the oil, heating coils are fitted in these tanks. Pneumercator gages and electric float alarms are also fitted to the settling tanks. The removal of the settled water from the tanks is done by the transfer pumps, which have special connections for this purpose, so arranged that it will not be possible for the pumps to draw oil from the settling tanks and discharge it overboard.

From the settling tanks the oil-pressure pumps take their supply through suction strainers, discharging through the heaters and discharge filters to the burners in the furnaces. A ring main is fitted in each boiler room to which each pumping unit is connected. An emergency connection is also made to this ring main so that the pressure pumps can draw directly from the oil-storage tanks. Special attention has been given to the fire-extinguishing arrangement in the boiler room.

With a view to speedy detection of oil on the double-bottom tank tops, a special skeleton arrangement of stokehold flooring has been fitted. Broad working gangways have been fitted in front of the furnaces, but these gangways are kept well clear of the bulkheads, leaving an open space to view the tank top and oil gutters. No wood has been used in the construction of the flooring.

Special gas-exhausting nozzles and pipes with connections to the oil-suction mains have been fitted to remove dangerous gases from the storage tanks before these are entered for inspection.

Cleaning and Putting Vehicle-Type Lead-Acid Battery in Service

The following is an abstract from Circular No. 92, "Operation and Care of Vehicle-Type Batteries," issued by the United States Bureau of Standards, Washington, D. C. This circular contains 93 pages and treats of both lead-acid and nickel-iron types of batteries. In addition to the instruction for the care and operation of different batteries a number of forms for use in keeping record of battery performance and maintenance records are given. Copies of this circular can be obtained at 30 cents each by addressing Superintendent of Documents, Government Printing Office, Washington, D. C.

Deposit of Sediment Accumulates

During the normal operation of a cell there is a constant wear of the plates, which causes a deposit or sediment to settle in the bottom of the jar. A space, usually referred to as the "mud space," having considerable capacity, is provided for the sediment.

The rate at which the sediment accumulates depends to a great extent upon the care which the battery receives in charging. If charging is carried on at such a rate as to cause violent gassing, the gas coming through the pores of the positive plate will tend to dislodge the active material, causing it to be deposited in the bottom of the jar. This condition is frequently referred to as "shedding of active material," and very materially shortens the life of the plate. This is one of the reasons why the charging current is reduced, when the battery begins to gas freely to a lower value called the "finishing rate." If a battery is regularly undercharged, the sulphate that remains unreduced on the negative plate will gradually accumulate and finally be washed away and deposited in the bottom of the jar. This is one of the reasons for giving a battery a regular equalizing charge in order to completely reduce the sulphate. If a cell is neglected and cleaning is delayed until the sediment accumulates sufficiently to reach the bottom of the plates, the wear will be increased on account of the local action caused by short-circuits through the sediment, and the cell will be discharged. Indications of this condition are low open-circuit voltage and low specific gravity.

To Determine Necessity for Cleaning

As the nature of the service requirements of a battery varies considerably, it is difficult to state definitely any means by which the necessity for cleaning may be determined. The best method of determining the condition of a battery appears to be a bench discharge test at normal rate, after an equalizing charge, with voltage readings of all cells in the battery. If, on such a test, any cell is found to be much below the others in capacity and the capacity of that cell cannot be restored by an overcharge, it should be removed and inspected for short-circuits or other trouble. This should be done after, say, 150 cycles of normal operation. Some types of cells are provided with extra-high ribs, which allow the accumulation of sediment during the entire life of the plates, thus eliminating the necessity of cleaning on this account.

Sulphation of Lead Batteries

Whenever a battery is discharging, lead sulphate ($PbSO_4$) is formed on both the positive and negative plates. After a normal discharge the sulphate is finely crystalline and of such a nature that it is easily reduced by the current flowing through the battery on charge. If charging is neglected and the battery allowed to stand in a discharged state, the crystalline condition of the sulphate gradually changes, filling the pores of the plates and eventually making the active material dense and hard, which prolongs the time required for a charge. It is this latter condition which is often referred to when a battery is spoken of as "sulphated."

Sulphation in this sense is always the result of some sort of abuse, as (a) standing discharged for some time, (b) neglecting evidence of trouble, (c) replacing loss of water by electrolyte, and (d) regular undercharging. A single cell in a tray may become sulphated by drying out as the result of failure to replace lost electrolyte or failure to replace a broken jar or by an internal short-circuit. During an equalizing charge where the specific gravity has reached a maximum in each cell, it indicates that all of the sulphate in the plates has been reduced. It is the negative plates generally which require a prolonged charge to reduce the sulphate. The active material of this plate is of a light color and hard and dense when in the discharged condition. The life of these plates, however, is shortened by sulphation.

Giving Battery Equalizing Charge

Once a week a lead battery which is used for operating a truck or tractor is to be given an overcharge known as an "equalizing charge." For this the daily charge is to be continued from the normal end at a rate equal to approximately one-half the value of the finishing rate until all cells are gassing freely and uniformly and until three consecutive readings of the specific gravity and voltage taken at half-hour intervals show no increase. If a battery shows a temperature exceeding 43 deg. C. (110 deg. F.), it should be cut off immediately and allowed to cool.

One a month the voltage and gravity readings of each cell should be recorded. These will serve as an indication of trouble within the cells such as sulphation or leakage, if there is a progressive change of the gravity readings.

The gravity of the individual cells should be adjusted to the proper value when the battery is first put in service or when it has been necessary to add electrolyte to any cell to replace that which has been spilled or otherwise lost. This should be done at the end of the equalizing charge. If the gravity of the cell is too high, a portion of the electrolyte may be withdrawn with the hydrometer syringe and replaced by distilled water. Similarly, the gravity may be

increased by replacing the portion drawn off by electrolyte. Before considering the adjustment complete, the equalizing charge should be continued to mix the electrolyte of the cell. The final value is shown by several consecutive constant readings at fifteen-minute intervals. The gravity should be adjusted to within five points, corrected for temperature, of the proper value.

Evidence of Plate Sulphation

Some of the evidences of sulphation are (a) continued low specific gravity, (b) continued low open-circuit voltage, (c) loss of capacity, (d) inability to take normal charge on account of increase of internal resistance, and (e) light color of positive and negative plates. The loss of capacity due to sulphation must not be confused with the natural loss of capacity during the life of the battery.

Whenever any of the foregoing evidences seem to be present it is well to give the battery an equalizing charge and then a continuous discharge at the normal rate down to 1.70 volts per cell. If it does not give rated capacity, as in cases of stubborn sulphation, empty out the electrolyte and fill the cells with water (distilled water preferred) and then charge in the usual manner. At the end of this charge read the specific gravity of each cell and the temperature of the pilot cell. Continue the charge at one-half the finishing rate, or as nearly this as possible. Read and record the specific gravity of each cell at regular intervals of, say, four to six hours. The charge at this rate is to be continued until the specific gravity of each cell has been constant for a period of at least twelve hours. The level of the electrolyte is to be maintained constant by the addition of water after the readings. If the water is added before the readings it will not be properly mixed with the electrolyte and false readings will be obtained. Hydrometer readings are to be corrected for temperature. Should the specific gravity of any cell rise above 1,300, draw out electrolyte to the top of the plates and replace by water. If the gravity is deficient, electrolyte should be added. The battery cannot be considered as completely restored until the specific gravity of all cells has remained constant for a period of at least twelve hours of continuous charging at one-half the finishing rate. The temperature must not be allowed to exceed 43 deg. C. (110 deg. F.). If necessary, the currents must be reduced or temporarily cut off. When a single cell of a tray is found to be sulphated it should be removed and treated separately.

If the battery is found to be sulphated, but with the sediment below the bottom of the plates, it should be treated in accordance with the foregoing instructions before cleaning. If the sediment has been allowed to reach the bottom of the plates the battery will be sulphated and should be cleaned before receiving treatment for sulphation.

The wood separators are to be renewed completely, and while many of the rubber separators may be used again it is well to provide about 25 per cent new ones.

Inspection of Trays

The trays should be examined to determine their suitability for further use. If found to be in good condition they should be washed out with water, to which soda has been added to counteract the effect of the acid. When thoroughly dry they should be painted with two coats of acid-resisting paint.

If the active material of the negative plates is swollen it must be pressed back into position before it is allowed to dry. A smooth board of suitable thickness is to be placed between each pair of plates and the whole group squeezed between smooth boards in a vise. Any loose particles adhering to the positive plates can be removed by means of a smooth piece of wood, or paddle. Do not wash the plates. All sediment is to be washed out of the jars. The jars are to be filled with electrolyte of specific gravity 1,250 to one-half inch above the top of the plates. If the battery is sulphated, water is to be used instead of electrolyte.

After the cells have been placed in the trays, and the old connectors pressed into position, the battery is to stand for several hours (some manufacturers recommend as long as ten hours), after which it is to be put on charge at the finishing rate. At the end of about fifteen minutes the voltage of each cell is to be read and recorded. This is to insure that the cells are connected right as to polarity. Any cell indicating less than two volts is probably connected backward and should be examined. The cells are now to be reconnected, if the battery is not sulphated, and after an equalizing charge it will be ready for service. A sulphated battery should be restored before reconnecting the cells permanently.

Universal Craftsmen Council of Engineers Meet at Springfield

The eighteenth annual convention of the Universal Craftsmen Council of Engineers was held at Springfield, Mass., during the week beginning Monday, Aug. 6. The Bridgeway Hotel was the headquarters, and in the Municipal Auditorium, a short distance away, the meetings of the delegates and the exhibit of the supplymen were held.

The lower floor of the auditorium was tastefully arranged in booths for the display of power plant equipment and engine-room supplies. The uniformity of decoration and the general color scheme of white and light green was most pleasing to the eye. There were 105 firms represented and the exhibit was liberally patronized during the week.

The several sessions of the engineers were held in the Mahogany Hall of the auditorium. There were present 102 delegates, representing 190 votes. It proved a busy week for the delegates in disposing of the accumulated business of the past year, and many important resolutions were adopted toward the building up of the organization, special interest being manifested in the educational features of the local councils during the coming year.

The Universal Craftsmen Council of Engineers was organized in Cleveland, Ohio, on Sept. 14, 1903, with four councils, located respectively in Chicago, Cleveland, Detroit and Rochester, with a combined membership of 248. At present there are fifty-six councils with an approximate membership of 9,500. In the past four years there has been an increase of 40 per cent in the membership it is claimed.

In the early part of the week all of the past grand worthy chiefs assembled and formed a Past Grand Worthy Chiefs' Association. O. N. Pomeroy, of Chicago, the first worthy chief of the grand body, was made president of the new association.

The ladies present numbered upward of sixty, and on Friday afternoon, permission having been given by the main body, the ladies convened and formed what will be known as the Ladies' Grand Council of the Universal Craftsmen Council of Engineers. Mrs. Joseph Nichols was chosen president; Mrs. David McGregor, vice-president, and Mrs. James Bunce, secretary-treasurer.

On Tuesday morning the opening exercises were held. Walter H. Damon, chairman of the convention committee, was the master of ceremonies, and after a brief address introduced Mayor Arthur A. Adams, who cordially welcomed the visitors to the city. Worthy Chief Frank Conroyd responded and thanked the mayor for his warm welcome. Raymond T. Wilber, Convention Secretary of the Chamber of Commerce, told the audience that the Chamber of commerce was at its disposal, and it was the wish of that body that the stay of the visitors would be so enjoyable that they would all be glad to come again.

On Thursday afternoon there was a steamboat excursion to Forrest Park, where an appetizing clambake was served; fully 400 guests were seated at the tables. During the day outdoor sports of various kinds were enjoyed, with prizes for the winners. The festivities ended with a baseball game between the Engineers and Supplymen.

On Friday evening in the Concert Hall of the auditorium an entertainment was given. There was an organ recital with several enjoyable numbers furnished by Bob Jones, France Packing Co.; Louis Serre, Jenkins Bros.; Jack Armour of *Power*, and others.

During the week there were theater parties, auto rides, shopping trips and visits to places of interest in the city.

The grand officers elected were: Frank Conroyd, past worthy chief, Chicago; Andrew Benner, worthy chief, Columbus: W. G. Warfield, assistant chief, Newark, N. J.;

Thomas H. Jones, secretary, Washington, D. C.; John O'Brien, treasurer, Chicago; Henry W. Burton, warden, Cleveland; P. H. Early, chaplain, Milwaukee; James M. Patton, guard, Buffalo. The three trustees comprise G. C. Brown, chairman, Pittsburgh, Pa.; W. W. Law, Princeton, N. J.; J. W. May, Brandon, Canada.

Frank Conroyd, retiring chief, was the recipient of a silver service and Walter H. Damon received a traveling bag in token for his excellent work as chairman of the convention committee. Progressive Council, No. 12, of Newark, N. J., presented the grand body a service bag for carrying the paraphernalia of the organization.

Preceding the installation of officers on Friday afternoon memorial services were conducted for the brothers who had passed away during the year. Chaplain P. H. Early officiated.

Toronto, Canada, was selected as the next convention city in August, 1921.

Seattle Considers Means to Relieve Power Shortage

In the discussion of means of relieving Seattle of its power shortage and of insuring continued power supply at lowest practicable cost, J. D. Ross, superintendent of lighting for the city, urges the speedy drilling of a tunnel at Cedar Falls. This tunnel, if drilled, will be 11 ft. diameter by 8,500 ft. long.

This course is urged as an alternative for the use of steam-driven electric generators. The Pacific Coast Coal Co. is said to have presented the City Council with an estimate for powdered coal for the Lake Union steam station to take the place of the Cedar River tunnel. Mr. Ross says that the above coal company gives an estimate of $640,000 to equip only 57 per cent of the steam boilers, which would mean a cost of over $1,000,000 to equip the entire plant. They estimate that on $1,000,000 worth of coal they could save $200,000 a year over the cost of oil which would leave $800,000 to add to the first cost of $640,000, or a total of $1,440,000 during the first year. While the tunnel would cost $1,100,000 and be a perpetual asset, the million dollars worth of coal on the other hand would be a dead loss and would soon have to be repeated. When Skagit power comes in all coal machinery would lie idle and would mean useless overhead charge.

Powdered coal delivers most of its ash to the smokestacks. Last year alone 90,000 tons of coal or 1,800 carloads would have been required at Lake Union, giving 11,250 tons of ash most of which would deluge the residences for a mile around.

For conditions at Seattle Mr. Ross thinks that powdered coal is a doubtful experiment. The Stone & Webster Co. tried to make it a success at its Western Avenue plant, he contends, but has not succeeded so far, and went to stoker feed at its largest plant at Georgetown.

The coal company on the same day they gave this estimate predicted a 20 per cent raise in coal if the new freight rates go into effect.

Governor Hart has just issued a warning that all cars available will be taken to the eastern and middle states.

Mill refuse is not available at any price for more than one-third of Seattle's needs, and even if it were available is dependent on whether a few lumber mills run or close down. There are 63,000 customers and service must be dependable.

Fuel equipment cannot be bought and installed as quickly as the tunnel can be built as machinery is hard to get. On the other hand, the tunnel requires only labor and concrete both easy to get locally.

The builders of the Elizabeth tunnel in California estimate that this tunnel at Cedar Falls could be built in four months actual working time by opening several adits. According to Mr. Ross, several well-known contractors are willing to take the job at $100 per ft. of tunnel. All machinery would be ready for 50,000 hp. without additional work. This summer not more than 2,000-hp. capacity is available at Cedar Falls and present equipment delivers only about 15,000 hp. during the winter months.

Shipping Board Contracts for Fuel Oil

The United States Shipping Board announces that it has entered into a contract with the Standard Oil Co. of New Jersey for supplying fuel oil to Shipping Board ships as follows: New York, 9,300,000 bbl. at $2.30 per bbl. terminal delivery and $2.40 barge delivery; Baltimore, 1,500,000 bbl. at $2.27½ per bbl. terminal delivery and $2.37½ barge delivery; Norfolk, 3,475,000 bbl. at $2.60 per bbl. terminal delivery and $2.70 barge delivery; Charleston, 400,000 bbl. at $2.15 terminal delivery; New Orleans (Baton Rouge), 1,150,000 bbl. at $1.90 per bbl. terminal delivery and $2.05 barge delivery. The following awards on bids for supplying fuel oil have been made: Atlantic Refining Company, Philadelphia, Pa., 3,000,000 bbl. of C grade fuel oil at $2.30 per bbl. terminal delivery and $2.38½ barge delivery, Philadelphia, Pa., deliveries to be made during the calendar year 1921; Gulf Refining Company, Pittsburgh, Pa., 125,000 bbl. of C grade fuel oil at $2.10 per bbl. terminal delivery and $2.20 barge delivery at Port Arthur, Tex., deliveries to be made over a period of six months beginning Oct. 1, 1920; Midco-Mexico Company, Tulsa, Okla., 4,900,000 to 7,000,000 bbl. of C grade fuel oil at $1.10 per bbl. terminal delivery for the first year and $1.25 for the next two succeeding years at New Orleans, deliveries to start on or about Jan. 1, 1921.

Water Power Commission Holds Hearings

Carrying out its policy to hear criticisms of regulations to be used in administering the Water Power Act, the Federal Power Commission on Aug. 12 listened to the views of those interested in the form of permit which will be used in making applications for power sites. The day following, representatives of banks and bond houses were heard on the regulations which have a bearing on the financial aspects of the law.

The Great Falls water power project, on the Potomac, is to be the subject of a hearing before the Power Commission on Aug. 24. All railroads entering Washington have been invited to send representatives to the hearing. All large consumers of power in Washington and throughout the Great Falls area will be represented at the hearing. The Commissioners of the District of Columbia and the public utilities commissioners of Virginia and of Maryland also are expected to be in attendance.

Major L. W. Call, of the Judge Advocate General's office, has been transferred to the Federal Power Commission and will serve as its chief counsel.

Domestic exports of electrical machinery and appliances from the United States by countries during May, 1920, as shown by the monthly report of the Department of Commerce, Bureau of Foreign and Domestic Commerce, are as follows: Batteries valued at $676,624; carbons valued at $129,546; dynamos and generators valued at $549,251; fans valued at $152,100; arc-lamps valued at $38.17; incandescent lamps (carbon filament) valued at $55.66, (metal filament) valued at $343,843; magnetoes and spark plugs, etc., valued at $360,317; meters and measuring instruments valued at $288,021; rheostats and controllers valued at $433.65; switches and accessories valued at $269,794; telegraph apparatus valued at $41,752; telephones valued at $414,838; transformers valued at $319,992, and other electrical apparatus valued at $2,869,808.

The Swiss Standards Association in a communication to various national engineering standardizing bodies proposes the standardization of widths across flats on nuts and bolt heads. The proposal covers the range of ¼ in. (6 mm.), 3 in. (80 mm.) diameter of bolts. Standardizing bodies of America, Belgium, England, France, Germany, Holland and Sweden received copies of the communication. The American Engineering Standards Committee has requested the American Society of Mechanical Engineers and the Society of Automotive Engineers to act as joint sponsors.

Sidelights on the Coal Situation

As a part of their campaign for better car supply to overcome the existing shortage in soft coal, bituminous operators in the National Coal Association have urged the Interstate Commerce Commission to take drastic steps to regulate the distribution of open top car equipment to small country "wagon" mines, hundreds of which have sprung into activity during the coal shortage emergency. It is roughly estimated that there are upwards of 3,000 mines of this character throughout the bituminous coal fields.

These so-called "wagon" mines, which are a considerable factor at this time in the speculative field, are located from one-half mile to 5 miles away from a railway switch, and have to haul their output by wagon or motor truck to the tracks. The mines, having only a small tonnage, draw upon the railroads daily for equipment, tying up cars at the switches because of their necessarily slow method of loading coal. Hundreds of cars which are needed to overcome the shortage in equipment in movements from the soft coal fields where facilities exist for quick loading and expeditious handling of the output, are in this way tied up.

The strike of daymen in the Middle West caused the production of soft coal during the last week of July to drop below the 1919 level for the first time this year. The total output, including lignite and coal coked at the mine, is estimated at 9,357,000 net tons, a decrease when compared with the latest pre-strike week, of 1,523,000 net tons.

Unlike the production of soft coal, that of anthracite increased during the week ended July 31. Shipments originated by the principal carriers (in part estimated) amounted to 36,487 cars, the largest since the middle of June. The total output, including mine fuel and local sales, is estimated at 1,874,000 net tons. This was 104,000 tons greater than that of the preceding week, and 62,000 greater than during the corresponding week of 1919.

Cumulative production since January 1, 1920, now stands at 50,575,000 tons, as against 47,307,000 tons in 1919.

A decrease of 15,000 tons marked the production of beehive coke during the week ended July 31. The total output is estimated on the basis of shipments over the principal carriers at 370,000 net tons, 4 per cent less than that of the preceding week. Production in the Connellsville region, as reported by the Connellsville *Courier*, decreased from 182,145 to 172,870 tons.

The cumulative output since the beginning of the year now amounts to 12,286,000 tons, an increase of 15 per cent over 1919.

Society Affairs

A National Conference of engineering employment sponsored by the American Association of Engineers will be held in Chicago on November 12, 1920. Practically all free employment bureaus will have representatives at this conference. All employment managers of the large industries and employers of technical men will be invited to attend and participate. The object of this conference is to provide a forum for solution of industrial relations problems affecting employers and engineers.

The American Association of Engineers has succeeded in having a board appointed by the Navy Department to consider the salary needs of the navy technical force and other employees. An A. A. E. committee consisting of J. T. Maguire, K. D. Williams and District Secretary R. C. Bailey appeared before the board on August 5 and presented data which indicates the need of about a 40 per cent increase. An increase of somewhat less than this was requested by the committee. The board will report on the 20th of August and the Navy Dept. will take action upon the recommendations on September 1. The members of the board are Captain J. K. Robison, L. McK. Howe and A. J. Berres.

Personals

D. B. Rushmore, chief engineer of the power and mining department of the General Electric Co., has been elected vice-president of the American Welding Society.

C. V. Peeling, formerly manager of the Cornwall (Ont.) Street Railway, Light & Power Company, has become connected with the Palmetto Power & Light Company, Florence, S. C.

A. T. Hardin, vice-president of operation of the New York Central Railroad, has been appointed by W. S. Murray, head of the super-zone engineering staff, to the advisory board, representing the New York railroads.

The American Society for Testing Materials has appointed C. D. Young as its representative on Engineering Council to succeed Albert Ladd Colby. Mr. Young is General Supervisor of Stores, Pennsylvania System, Broad Street Station, Philadelphia, and Vice-President of the American Society for Testing Materials.

H. W. Butler has been designated as industries division engineer of the super-power zone engineering staff. Mr. Butler is a graduate of Cornell University and was connected with the Interborough Rapid Transit Co. until 1907, when he resigned to accept a position with J. G. White & Co., with whom he was engaged until 1913. Later he did consulting work in New York. During the war he was assigned to the aircraft production department of the Army.

New Publications

TIN SHEET-IRON AND COPPER-PLATE WORKER. By Leroy J. Blinn. Published by Henry Carey Baird & Co., Inc., New York City. Cloth, 5 x 7¾ in.; 334 pages.

This volume is a new and enlarged edition, containing many new problems in metal plate work and should prove of practical value to workers in tin, sheet-iron and copper plate. The book is brought up to date with the addition of new problems which deal more particularly with triangulation and modern skylight work. A noteworthy feature is the treatment of metallic alloys and solders; the more important seams or joints used in plate work and the various ways of making them are illustrated and described in a clear and concise manner. There are suggestions for tempering and for other operations useful in the workshop, also numerous useful tables designed to furnish a quick guide and save time. Valuable recipes of all kinds round out this most complete work. Included in its chapters are rules for describing various kinds of patterns, practical geometry, mensuration of surfaces and solids, tables of the weights and strength of metals and other materials, tables of areas and circumferences of circles, composition of metallic alloys and solders. A most complete index enables quick reference to the subject matter.

Trade Catalogs

"Science in Industry" is the title of a 26-page booklet just published by M. H. Avram & Co., Inc., New York City. The booklet contains a discussion of the province of industrial engineering and explains the need of a systematic method of scientific guidance and control whose application would tend to decrease industrial waste and strengthen industrial effectiveness.

The Traylor Engineering & Manufacturing Co., of Allentown, Pa., has ready for distribution a new 50-page catalog entitled "The Traylor Superpump and Hydraulic Machinery." The booklet gives a comprehensive idea of the constructional details of the Traylor Superpump. It should prove of practical value to the operating engineer and will give the purchaser data pertaining to the selection of pumping equipment. A copy will be sent on request.

The Kelly Controller Co. of Chicago has just completed publication of two new catalogs entitled respectively the "Kelly High Pressure Controller" and the "Kelly Low Pressure Controller." The first contains descriptions and illustrations of the high pressure controller manufactured by that company and a table of dimensions of the various parts of the article. The second contains a description of the low pressure controller, with photographs and line drawings.

The Edward R. Ladew Co., Inc., manufacturer of leather belting, 54 Franklin St., New York City, has just finished publication of a new 20-page catalog entitled "A Study of Various Types of Belting." The booklet contains a study of various types of belting and belt-testing equipment. The results of a number of tests are also given, together with curves illustrating the horsepower transmitted at various percentages of slip. A copy of the catalog will be sent on request.

Fan System of Heating, Ventilating and Humidifying is the title of a 115-page catalog ready for distribution by the Buffalo Forge Co., Buffalo, N. Y. In the volume particular stress is laid on the principles underlying all the various steps in the determination of suitable apparatus to meet all conditions of heating, ventilating and humidifying. A brief history of the heating and ventilating art in public buildings is given. This is followed by a comparison between natural and mechanical ventilation and several tests made of each system. A synthetic air chart designed as a convenient method of recording data and arriving at a final percentage of perfect ventilation is given. The chart includes all the known factors that influence the ventilation of a room. Some of the other subjects presented are heating, room temperature, heat losses, humidity, psychrometric charts, carrier air washers, humidity control; ventilation in hospitals, libraries, schools, theaters, churches, department stores. Heating, ventilating and humidifying in industrial plants are treated in a comprehensive manner in part two of the book. Part three describes the Buffalo apparatus, and part four deals with fan engineering problems.

Business Items

The Chicago Fuse Manufacturing Co. has acquired a new factory comprising a frontage of 140 ft. on Laflin St. and 360 ft. on Fifteenth St., Chicago. The building is a two-story factory structure with a four-story office section, and contains a total floor space of 125,000 sq.ft.

Greene, Tweed & Co., New York, announce to operators of steam power plants the completion of arrangements to manufacture the Rochester Automatic Lubricators in their new plant at Newark, N. J. This plant is to be under the supervision of one of their vice-presidents.

M. H. Detrick Company, manufacturers of flat suspended arches and steam jet ash conveyors, announce the opening of an Eastern branch office at 30 Church Street, New York City. This office will be under the management of R. D. Foltz, former Assistant Mechanical Engineer, who has been appointed Eastern Sales Manager. Mr. Foltz will supervise the New York, Boston, Hazelton and Philadelphia offices. Harry S. Sleicher will continue to handle all sales matters in the New York territory.

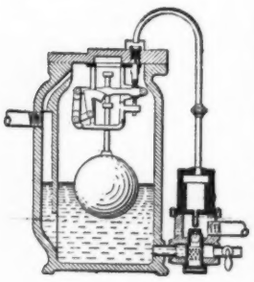
Condensed-Clipping Index of Equipment

Clip, paste on 3 x 5-in. cards and file as desired

Trap, Miller Steam

C. J. Miller Co., 1225 Columbia Ave., Philadelphia, Pa.

"Power," June 22, 1920

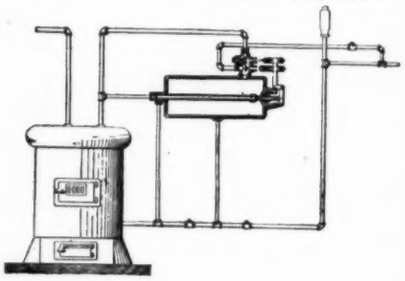


This trap is designed to use with machinery when constant temperature and thorough draining of condensation is desirable. Condensation enters through an inlet pipe and a float holds a lever down, which in turn holds the pilot valve from its seat. Steam and air then flow through the pilot-valve disc and close the discharge valve. As the water rises in the trap, it pushes the float upward until the pilot valve is closed, which action cuts off steam from the cylinder. An air vent releases the pressure in the trap, and the discharge valve is forced wide open to the discharge pipe. Removing the seat holder from the bottom of the valve permits of the seat and valve being easily removed for regrinding or renewal.

Controller, Kelly Thermo Return

Kelly Controller Co., 175 West Jackson Boulevard, Chicago, Ill.

"Power," July 13, 1920

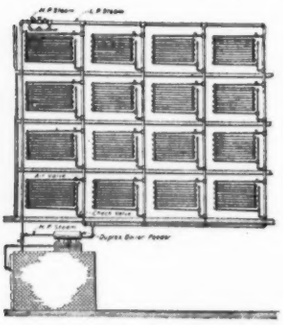


This device is designed to return water to the boiler against any back pressure and keep the return lines dry. It is thermostatically controlled, and the operating mechanism is visible and accessible. A steam line is connected from the boiler to the controller chamber. A check valve prevents a back flow of water from the boiler. When the return water has accumulated in sufficient quantity to cover the thermostat, the thermostat contracts thereby closing one valve and opening another, which action permits steam at boiler pressure to enter the receiver and thus allows the water to return to the boiler by gravity.

Heating System, Farnsworth

Farnsworth Co., Conshohocken, Pa.

"Power," June 29, 1920



This system consists of a duplex boiler feeder which permits of a continuous flow of condensate into the boiler at a temperature only one or two degrees below that of the steam corresponding to the pressure carried in the system. There are no vent openings to the atmosphere and practically no heat loss. The return line from the risers is carried through the boiler meter, which is located above the water line of the boiler. There is no return line other than to connect the risers through the boiler feeder. The condensate is held under a pressure and is fed directly into the boiler.

Grease Cup, Harrison Center Thread

H. & H. Motor Specialties Co., Inc., 755 Boylston St., Boston, Mass.

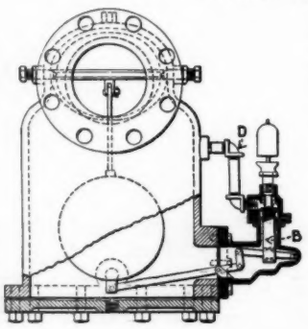
"Power," 1920

This grease cup is made with a drawn-steel base with a screw plate electrically welded to it. The cap consists of a drawn-steel shell with a screw electrically welded in the center. A heavy leather washer fits over the hexagon base and is reinforced with a steel washer. The screw plate is provided with four holes through which the grease is forced into the base, and which prevents emptying the base when removing the cap.

Controller, Kelly High-Pressure

Kelly Controller Co., 175 West Jackson Boulevard, Chicago, Ill.

"Power," July 13, 1920

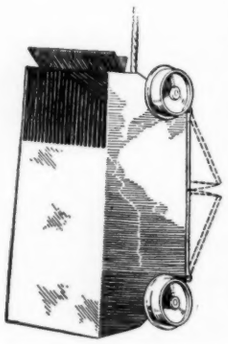


This controller is designed primarily for single boilers and acts as a steam separator when inserted in the steam-supply line from the boiler. The float is connected to a butterfly valve at the upper side and to another valve from the lower side through a series of levers. When the quantity of water separated from the steam becomes greater than can be carried away through the bleeder opening, the float rises and pulls the stem downward, which allows steam to be supplied through a pipe to blow an alarm. If an excessive amount of water accumulates, the float rises and closes a butterfly valve, thus preventing the water from entering the steam main.

Skip Hoist-Transporter, Improved Balanced

Exeter Machine Works, 30 Church St., New York City.

"Power," 1920

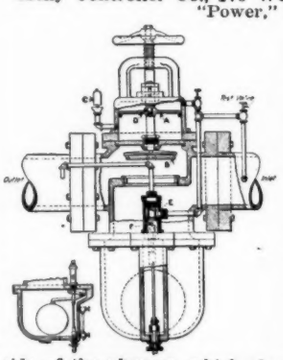


Combines horizontal transportation with hoisting operation in a single machine. Coal is loaded at an opening in the upper front side and discharges through a single- or double-hinged door on the opposite side, when the skip is on a horizontal track. The doors are held closed by a latch, which is operated for discharging by a tripper arranged along the track. This tripper can be shifted to any desired position for dumping. The skip hoist and one-half of its load is balanced by a counterweight which operates only during the vertical motion of the skip. When lowering the empty skip, the motor raises the counterweight. A second counterweight takes up the slack rope paid out during the horizontal travel of the skip. A third weight carries the skip back after discharging.

Valve, Quintuple-Duty Steam

Kelly Controller Co., 175 West Jackson Boulevard, Chicago, Ill.

"Power," July 13, 1920



This valve combines five separate functions in that it automatically protects the boiler main and engine by closing when a rupture occurs in either the boiler or mains, or when the boiler primes. It also acts as a non-return or a check valve, as a main protection, as a steam trap, as an engine protection and as an equalizing valve. Should the boiler pressure become lower than the header or steam main pressure, the weight of a plunger and a disk closes the valve slowly against the cushioning action under the plunger. Should the main header burst, the pressure lowers on the top side at the auxiliary valve, and as boiler pressure is under this valve it opens, allowing steam to be applied to the upper side of the plunger, which closes the main valve.

Trap, Ellis Tilting Steam

Ellis Drier Co., Chicago, Ill.

"Power," July 27, 1920

Water of condensation runs into the receiving tank through a trunnion. When sufficient water has entered the tank to counterbalance the weight which is within the tank between a double head, the tank tilts, opening a valve which allows steam to enter the receiver through a vertical pipe and forces the condensation out of the trap. As soon as the water is discharged, the counterweight brings the tank back to horizontal, or filling position. The new position of the counterweight produces a rapid tilting action. When the trap begins to tilt, the center or gravity of the counterweight moves forward as it swings through its arc. Tempered springs act as a shock absorber, and a relief valve attached to and below the steam valve is always open when the trap is filling. The tank has welded seams and is tested to 150 lb. pressure.

Patented Aug. 20, 1918

New Construction

PROPOSED WORK

Me., Saco—The Garland Mfg. Co. is in the market for motors, etc.

N. H., Manchester—The Bd. Educ. will receive bids until August 31 for a 3 story high school including a steam heating system. About $450,000. C. R. Whitcher, 814 Elm St., Archt.

N. H., Manchester—The Bd. Educ. will receive bids until August 31 for a 3 story, 100 x 110 ft. high school including a steam heating system on Notre Dame Ave. About $300,000. W. E. Provost, 581 Union St., Archt.

Vt., Brandon—The Health Comn. plans to build a 1 story central heating plant at the State Hospital here. A. S. Kellogg, 53 State St., Boston, Mass., Engr. Frank L. Austin, College St., Burlington, Archt.

Mass., Athol—The town will receive bids about September 10 for a 2 story, 50 x 125 ft. memorial hall including a steam heating system on Main St. About $250,000. Brainerd, Leeds & Kellogg, 89 Franklin St., Boston, Archts.

Mass., Cambridge—The city received bids for the installation of a heating and plumbing system in the proposed 3 story, 77 x 140 ft. hospital addition on Mt. Auburn St., from Lynch & Woodward, 287 Atlantic St., Boston, $16,675.

Mass., Greenfield—The town is having plans revised for a 3 story high school including a steam heating system on Federal and Saunderson Sts. About $400,000. Harry Richardson, Chn. Patton & Blair, 579 5th Ave., New York City, Archts.

N. Y., Brooklyn — William H. Gompert, Archt. and Engr., 171 Madison Ave., New York City, will receive bids until August 23 for a 2 story, 50 x 120 ft. bank building including a steam heating system for the Homestead Bank, 141 Penn Ave., East New York. About $300,000.

N. Y., New York — The Interborough Rapid Transit Co., 165 B'way, is in the market for conveying and hoisting machinery for the new storage yards at New Lots and Stanley Aves., Brooklyn.

N. Y., New York—The J. P. Morgan Co., 23 Wall St., is having plans prepared for a 20 story office building addition including a steam heating system at 11-21 Broad St. About $4,000,000. Trowbridge & Livingston, 527 5th Ave., Archts. and Engrs.

N. Y., New York (Borough of Richmond) —The Dept. of Pub. Welfare, Municipal Bldg., New York City, will receive bids until August 20 for furnishing, delivering and installing boilers in the proposed addition to the present boiler house at Sea View Hospital, here.

N. J., Point Pleasant—The Lakewood & Coast Electric Co. plans to build a 15 mi., 13,200 volt, 3 phase, transmission line from here to the Borough of Seaside Heights and is in the market for equipment for same. S. W. Borden, Summit, Genl. Mgr.

N. J., Trenton — W. H. McElfatrick, Archt., 701 7th Ave., New York City, will soon award the contract for a 2 story, 100 x 250 ft. theatre including a steam heating system on South Broad St., for the Trent Theatre Bldg. Co. About $800,000.

Pa., Philadelphia — Stewart A. Jellet, Engr., Real Estate Trust Bldg., will soon award the contract for a 1 story, 40 x 76 ft. power house for the Ferguson Carpet Co., Stenton and Rockland Sts.

Pa., Philadelphia—The Lit Bros., Market and 8th Sts., will soon award the contract for a 5 story, 76 x 80 ft. boiler house at 719 Filbert St. Stewart A. Jellet & Co., Real Estate Trust Bldg., Engr.

Md., Dundalk (Baltimore P. O.)—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., Baltimore, plans to build a large steam power plant here.

D. C., Washington—The Office of the Chief Signal Officer, War Dept., will receive bids until August 26 for furnishing five, 1 kw., 115 volt telephone motor generators.

W. Va., Spencer—The Spencer Water & Ice Co. has purchased the plant of the Wieland Electric Co. and plans to install 2 new generators, and a 200 hp. engine in addition to the 20 hp. engine now in use.

Tenn., Memphis — The Mississippi River Comn., 1st and 2d Districts, Custom House, will receive bids until August 26, for furnishing and delivering 5 return-flue boilers for the U. S. S. Chisca.

Tenn., Nashville—The Morgan & Hamilton Co., 1400 8th Ave., N., plans to build a bleachery. Steam and electrical equipment will be installed in same. J. B. Morgan, Pres. and Genl. Mgr.

Ky., Henderson—The Canoe Creek Coal Co. is in the market for electrical equipment, etc. About $1,000. Alex. Blair, Jr., Supt. and Mgr.

O., Cleveland—The city received bids for furnishing one 10,000-kw. steam turbo generator condenser, auxiliaries and switchboard from the Merchants' Light & Heat Co., Indiana, $284,350; Westinghouse Electric & Mfg. Co., East Pittsburgh St., Pittsburgh, $285,567; Allis-Chalmers, Park Bldg., Pittsburgh, $300,000.

O., Cleveland—The Masonic Temple Association, c/o Albert Wright, of the Otis Elevator Co., 1373 East 6th St., plans to build a 21 story, 96 x 150 ft. masonic memorial building including a steam heating system at 3500 Euclid Ave. About $4,000,000. Hubbel & Benes, 4500 Euclid Ave., Archts.

O., Cleveland—The Standard Oil Co., 26 B'way, New York City, is having plans prepared for a pumping plant here. About $1,000,000.

O., East Cleveland (Cleveland P. O.)— The Bd. Educ., Williamson Bldg., Cleveland, received bids for a 1 story, 48 x 66 ft. heating plant in the proposed Prospect school from the Drummond Miller Co., 4500 Euclid Ave., Cleveland, $56,900; C. Peterson Co., 4500 Euclid Ave., Cleveland, $63,500; Tenbusch Parker Constr. Co., 1836 Euclid Ave., Cleveland, $63,696.

O., Lakewood—The Bd. Educ., 1456 Warren Rd., will receive bids until August 25 for a 2 story, 44 x 92 ft. grade school addition to the Lincoln, McKinley and Franklin schools. Plans include the installation of a steam heating system in each. About $250,000. C. W. Hopkinson, Rose Bldg., Cleveland, Archt.

Ind., Ft. Wayne — The Bd. of County Comrs. is having plans prepared for a 2 story county farm building near here. Plans include a power plant. About $600,000. C. R. Weatherhogg, Hamilton Bank Bldg., Archt.

Ind., Indiana Harbor—C. E. Potts, c/o Inland Steel Co., Mill Block Ave., will soon award the contract for a 1 story, 100 x 300 ft. theatre including a steam heating system. About $350,000. Henry L. Newhouse, 4630 Prairie St., Chicago, Ill., Archt.

Ind., Petersburg—The Bd. of Co. Comrs. will receive bids until August 30 for a 3 story, 110 x 110 ft. court house including a steam heating system. About $400,000. Elmer E. Dunlap, 909 State Life Bldg., Indianapolis, Archt.

Mich., Ann Harbor — The University of Michigan is having plans prepared for dormitory buildings including a steam heating system. About $700,000. York & Sawyer, 50 East 41st St., New York City, Archts. and Engrs.

Mich., Dearborn — Malcolmson, Higginbotham & Palmer, Archts., 405 Moffat Bldg., Detroit, will soon award the contract for a 1 story, 46 x 87 ft. power house including equipment for same for the Bd. Educ. About $50,000.

Mich., Detroit—Baxter O'Dell & Halpin, Archts., 1024 Hammond Bldg., will soon award the contract for a 2 story, 45 x 96 ft. factory including a steam heating system and an electric motor for power on Field and Forest Sts., for the Weyhing Bros., 237 Woodward Ave. About $100,000.

Mich., Flint—The Y. M. C. A. is having plans prepared for several dormitory buildings including a steam heating system. About $500,000. Davis, McGrath & Kiesh-ing, 220 5th Ave., New York City, Archts and Engrs.

Mich., Lansing—The Bd. Educ. had plans prepared for a 3 story, 80 x 306 ft. school including steam heating equipment. About $325,000. J. N. Churchill, Archt.

Ill., Savannah—The Construction Division, War Dept., Wash., D. C., plans to build 47 buildings including a small heating plant to have 100 hp. boilers, here. About $3,000,000.

Minn., Fairmont—The Martin Co. Electric Service Co. Inc. is having plans prepared for installing 28 mi. of transmission line from here through Welcome and Ceylon, to Dunnell. About $28,000. W. E. Skinner, 3241 Aldrich Ave., South Minneapolis, Engr.

Wis., Hartford — The Kissel Motor Co. will soon receive bids for furnishing pipe boilers, etc., for the boiler plant. About $25,000. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Wis., Marshfield—The city plans to build an addition to the boiler house and will receive bids until August 27 for stokers, feed water heater, superheaters, etc., in same. J. Seubert, Clk. Cahill & Douglas, 217 West Water St., Milwaukee, Engrs.

Wis., Milwaukee—The H. N. Davis Co., 129 Michigan St., will soon award the contract for a 2 story, 60 x 110 ft. factory on 32nd St. Several electric motors will be installed in same.

Wis., Plymouth—The Service Motor Co. plans to build a 4 story, 60 x 200 ft. garage including electric power, etc. About $100,000.

Wis., Sheboygan—The Columbia Rubber Wks., 176 16th St., Milwaukee, is having plans prepared for a 2 story, 70 x 200 ft. factory addition including a steam heating system. Plans include a 30 x 40 ft. boiler house. About $75,000. Edward Juul, 805 North 8th St., Engr.

Wis., Sheboygan—The St. Nicholas Hospital Co., c/o P. Reiss, plans to build a 60 x 180 ft. power house on Superior St. About $50,000. Frank Geib, 1439 South 9th St., Engr.

Minn., Duluth — Cathedral Parish, 211 West 4th St., will soon award the contract for a 2 story, 110 x 150 ft. school including a steam heating system on 28th Ave. About $250,000. Maginnis & Walsh, 100 Boylston St., Boston, Mass., Archts.

Minn., Milaca—The city plans to install a new generator and probably an additional unit to the lighting plant. W. E. Skinner, 3241 Aldrich Ave., Minneapolis, Engr.

Minn., Minneapolis — The Bd. Educ. received bids for installing a heating and ventilating system in the proposed 2 story, 60 x 191 ft. grade school on 46th St. between 4th and 5th Aves., S., from H. Kelly & Co., 925 Plymouth Bldg., $21,197; Western Heating Co., 13 East 36th St., $22,980; Belden-Porter-Gray & Co., 914 Mary Place, $23,365.

Minn., Minneapolis—The Hennepin Atomized Fuel Co., B'way and Johnson Sts., N.E., plans to install equipment including pressure machines, driers, pulverizers, etc.

Minn., Stephen—The Minnesota Electric Distributing Co., Crookston, plans to extend its transmission line from here to Crookston, a distance of 50 mi.

Minn., Willmar — Hans Gunderson, City Clk., will receive bids until August 23 for a sewer sludge pump and a 5 hp. electric motor.

S. D., Plankinton—C. H. Nelson, Stickney; Mount Vernon Light & Power Co., Mount Vernon, and W. J. Peters, White Lake, all of S. D., plan to build a central power plant here and extend the transmission lines.

Ark., Ft. Smith—The city is having plans prepared for a waterworks project. Plans include 2 or 4 additional settling basins and equipment, 2 new boilers and 1 pumping engine. F. M. Smith, City Clk. Black & Veatch, Interstate Bldg., Kansas City, Mo., Engrs.

Utah, Ogden—The Construction Division, War Dept., Wash., D. C., has purchased a site here and plans to construct 35 buildings including a small heating plant to have 200 hp. boilers. About $2,000,000.

Cal., Los Angeles—The Bd. Educ. will receive bids until August 25, for furnishing all labor and materials for the installation of a boiler to replace the present boiler at the Virgil Intermediate School, 150 North Vermont Ave.

N. B., St. Stephen—The Maun Axe & Tool Co. plans to rebuild its plant which was recently destroyed by fire and is in the market for one 10 hp., 200 volt, 60 cycle 3 phase, a.c. induction motor, 900 r.p.m.; seven 20 hp., 200 volt, 60 cycle, 3 phase, a.c. induction motor, 1,200 r.p.m.; one 15

hp., 200 volt, 60 cycle, 3 phase, a.c. induction motor, 1,200 r.p.m., and one 40 hp., 200 volt, 60 cycle, 3 phase, a.c. induction motor.

CONTRACTS AWARDED

Mass., Arlington—The Bldg. Committee has awarded the contract for the installation of a heating and ventilating system in the proposed junior high school here, to the Ross Chase Co., Summer St., Boston, at $27,958.

Mass., Charlestown—The Palmer & Parker Co., 103 Medford St., has awarded the contract for a 1 story, 16 x 40 ft. boiler plant to W. H. Preble Co., 11 Pemberton Sq., Boston.

N. Y., Brooklyn—The Hebrew Institute of Borough Park, c/o L. A. Abramson, Archt. and Engr., 46 West 46th St., New York City, will build a 3 story school auditorium including a steam heating system. About $400,000. Work will be done by day labor.

N. Y., New York—Hotel Statler, Pennsylvania Hotel, New York City, has awarded the contract for a 2 story hotel addition including a steam heating system to George A. Fuller, 175 5th Ave., at $250,000.

N. J., Hackensack—The Hackensack General Hospital has awarded the contract for a hospital addition and power house to the W. H. White Constr. Co. at $150,000. Noted May 3.

D. C., Washington—The Bureau of Yards & Docks, Navy Dept., has awarded the contract for a boiler and piping, to the W. G. Cornell Co., 923 12th St., N. W., at $8,586.

Va., Brookneal—The Brookneal High School Bd. has awarded the contract for the installation of a heating system, in the proposed 2 story, 60 x 80 ft. high school to T. R. Marsh, Lynchburg.

Ga., Atlanta—The Red Diamond Motor Corp. has awarded the contract for an assembly building including a steam heating system to H. D. Best, 175 5th Ave., New York City, at $300,000.

O., Cleveland — The Fuller Dry Cleaning Co., c/o W. A. Theobald, 7606 Carnegie Ave., has awarded the contract for a 1 story, 29 x 40 ft. boiler house on East 77th St. near Carnegie Ave. to Paul Bros., 528 Citizens' Bldg., at $25,000.

O., Cleveland — The Sisters of the Notre Dame, 10510 Buckeye Rd., has awarded the contract for a 1 story, 23 x 64 ft. boiler house to Law & Strauss, Builders' Exch. Bldg., at $30,000.

Mich., Detroit—The Bd. Educ. has awarded the contract for installing a heating, ventilating and plumbing system in the proposed 2 story, 105 x 200 ft. Pattengill School on Northfield and Spokane Aves. to Irvin & Meier, 2289 Woodward Ave., at $94,272; in the proposed 2 story, 77 x 159 ft. George School on Russell and Superior Sts. and in the proposed 2 story, White School on Charles Ave. to James W. Partlan, 51 Park Pl., at $56,995; $92,850; and in the proposed Davidson School on Roman and Joseph Campau Aves. to the O'Connor Bros., Vinton Bldg., $85,741. Noted Aug. 3.

Ill., Chicago—J. A. Wetmore, Supervising Archt., Treasury Dept., Wash., D. C., has awarded the contract for repairing the boiler at the U. S. Marine Hospital here to the Chicago Down Draft Furnace Co., 115 South Clinton St., at $2,569.

Wis., Barron—The city has awarded the contract for the installation of machinery for power plant to Otto Berg., c/o Taylor Flour Mill.

Wis., Colfax—The Colfax Light & Power Co. has awarded the contract for furnishing a switchboard and motors, to the St. Paul Electric Co., 145 East 5th St., St. Paul, Minn., at $11,000.

Wis., Florence — The Peninsular Power Co. will build a hydro-electric plant here. Work will be done by day labor.

Wis., Glenwood City—The Apple River Milling Co. has awarded the contract for a transmission line from here to Emerald, a distance of 10 mi. including transformers to the St. Paul Electric Co., 145 East 5th St., St. Paul, Minn., at $10,000.

Wis., Milwaukee—The Amer. Shipbuilding Co., foot of 54th St., N.W., Cleveland, O., has awarded the contract for a 1 story, 50 x 100 ft. pump house on Washington St. to the Meredith Bros., 1043 Kinnickinnic Ave., at $60,000.

Wis., Peshtigo—The Peshtigo Pulp & Paper Co. has awarded the contract for a hydro electric power plant and dam 5 mi. from here, to Jorgenson Constr. Co., Denmark, Wis.

Minn., Farmington—The city has awarded the contract for a 500 gal. duplex or triplex pump, motor, etc., to the Power Equipment Co., 212 3rd Ave., N., at $3,194. Noted July 13.

Minn., Minneapolis — The Auto Intelligence Association, Schutte Realty Co., 1000 Soo Line Bldg., has awarded the contract for the installation of a heating system in the proposed 2 story, 132 x 165 ft. auto sales building on 4th and 6th Sts., S., to C. E. Hasey, 300 Builders' Exch. Bldg.

N. D., Osnabrock—The city has awarded the contract for the installation of a light and power plant, to the Electric Constr. Co., Grand Rapids.

N. D., Valley City—The city has awarded the contract for a 2 story, 80 x 89 ft. power plant, to McManis & Tarnoski, 484 Endicott Bldg., St. Paul, Minn., at $60,000.

Tex., Waco — Baylor University has awarded the contract for the construction of a heating plant, to J. S. Harrison & Sons and for equipment, to the Hill Bros., 705 Austin St.

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